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MORPHOLOGY OF THE LEGS OF HYMENOPTEROUS INSECTS.[1]

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ACCORDING to our modern philosophy regarding the origin and development of animal organs and organisms, we should look at such organs as are much used in the animal economy to find extremes in modification. Thus among mammals the teeth are

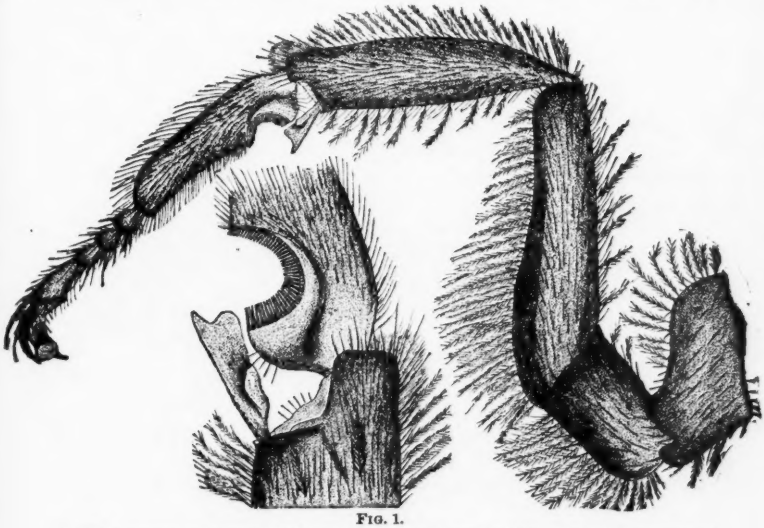

FIG. 1.

[1] This paper was read before American Association for Advancement of Science, in August, 1887, at N. Y. meeting.

most modified and very important in systematic mammalogy. For like reason the ornithologist looks to bill and feet in his study of families and genera. With the laws of variation and adaptation before us, we should expect to find modification carried to extremes among Hymenopterous insects. The life functions of these insects are so wonderful and varied that a maximum differentation of organs and structure is required for their execution. The chief tools used by these Hymenopterons are the legs and mouth organs, and it is to the former that I invite attention.

Let us consider the anterior or prothoracic legs of the honey-bee. We first notice (Fig. 1) a strong and interesting modification in the basal tarsus and tibial spur, which modification is known as the "antenna cleaner." At the base of the first tarsal joint and in the angle between it and the tibia is a short, hollow semi-cylinder. The concave surface of this cavity is smooth except at the outside margin, where there are from seventy-eight to ninety projecting hairs, which under the microscope remind one of the villi of the small intestines of mammals. These teeth, like hairs, projecting as a fringe, form a most delicate brush. The tibial spur is so modified as to resemble a very short handled razor, the blade of which is for a wide space facing the tarsus, a most delicate membrane, and this blade forms a sort of lid to the cavity just described. When the leg is straight this lid barely reaches the cavity; but when the first tarsus is flexed upon the tibia it serves as a cover to the cavity and really closes it.

The peculiar structure is found in both sexes and in the abortive females or workers of social bees, in all other bees, in all wasps so far as I have examined, in the Mutillidæ, Formicidæ in ants, in all the families of parasitic Hymenoptera except the Chalcids, while in the Cynips, Cynipidæ, Saw flies, Tenthredinidæ, and horn-tails, Uroceridæ, we find it nearly or quite absent.

We find the "antenna cleaner" in all species of bees—Apidæ—even in the curious species like the male of Megachile (Fig. 2), where the whole anterior leg is remarkably modified. In the bumble-bees species of the genus Bombus we find the antenna cleaner almost

FIG. 2.

exactly like that of the honey-bee, except the part which I have termed the blade, in the modified tibial spur has its back more extended, and the whole back of the blade and the extended point thickly set with short spines, reminding one of the serrations on the antennæ of many beetles like the Buprestids. In the carpenter-bees—Xylocopa—there is no variation from the type of the Bombus except the serrated margin of the blade is still more marked. In the female of the tailor-bees—Megachile—the extended point and serrations are both absent, and we have again the form of this organ in the honey-bee. The number of the teeth in the cavity however, is less, there being from forty-five to fifty. In Osmia and Andrena (Fig. 3), the arrangement is much as in the Xylocopa; in Nomada the serrations are less spinous and more scattered, while in the beautiful species of Angochlora the cavity is quite shallow, the blade of the spur narrow, and the spines on the back and point of the blade slim and hair like.

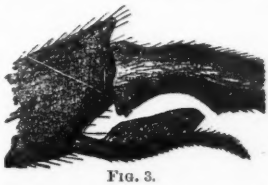

Fig. 3.

In the several families of wasps we find this pollen cleaner, well developed, and in some cases quite modified from the same in bees. In the paper-making wasps—Vespidæ—it is much as in the lowest bees—Nomada and Angochlora. The cavity is more shallow than in the honey-bee, the membranous portion of the blade is quite narrow, and the appendages on the point of the blade are hair-like, though those near the base remind one of saw teeth.

In sand-wasps—Bembecidæ—this organ is much as seen in bees and paper-making wasps; though the point of the blade is very long, and the back and point both thickly set with fine hairs.

Fig. 4.

In all species of mud wasps, belonging to the family Sphegidæ (Fig 4) we find an interesting modification in the spur. Here the membranous portion of the blade is nearly obsolete, while its inner margin is concave and fringed with a toothed brush much as seen in the cavity, though the teeth are shorter. The end of the blade is blunt, and bears from five to eight heavy appendages, which, when magnified, look like so many fingers.

In the beautiful mud wasps of the family Pompilidæ, this apparatus is much as in the Sphegidæ, except that the cavity is more shallow. The fringe on the spur is peculiarly fine and beautiful. The spur is pointed, the point being flat and margined on both sides with spines.

In the Mutillidæ this organ is specially well shown. The type is that of the bees and Vespidæ, as the blade is membranous and without the fringe. The back and both sides of the point, however, are covered with a row of spinous hairs.

In the ants—Formicidæ—(Fig 5) the cavity is shallow and the fringe well marked in the cavity and on the spur where it is double, and while this brush is beautiful, it is not widely different from the hairs on the point of the blade, and on the remaining part of the basal tarsus.

Fig. 5.

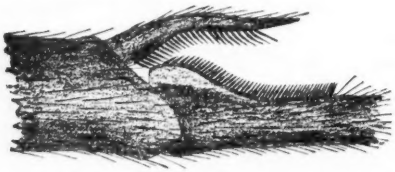

Fig. 6.

In Ichneumonidæ (Fig. 6), and Braconidæ we find this antenna cleaner, less developed, though still present. The cavity is hardly more than an inclined plane, the rise at the distal end being very slight. The spur is marked by a distinct concavity, and the fringe is present in the cavity and on the spur, though the brush in case is made up of coarser hairs than are found in bees or wasps.

In the species of Chrysidæ we find this apparatus more perfect than in the Ichneumonidæ. The cavity is deeper, the spur concave, and both show the comb or fringe well marked. The species of this family are unique in that the concave spur is fringed to the very point of the blade.

In the minute Proctotrupidæ the antenna cleaner is even less developed than in the Ichneumon flies. The cavity is almost wholly obsolete, the spur is only slightly concave, and the hairs forming the brush are hardly different from the other hairs of the leg. In the Chalcid flies—Chalcididæ—the cavity is wholly absent, and the only suggestion of this apparatus is in the slightly curved spur. The brush is also obsolete. The same is hardly less true of the gall-

flies—Cynipidæ. In the saw-flies—Tenthredinidæ—(Fig. 7), there is no hint of the cavity on the first tarsus; but a slight concavity of the spur, with the membrane just visible, still suggests the "pollen cleaner." In the horn-tails—Uroceridæ—the only reminder we have of the antenna cleaner is in the slightly curved spur. The membranous part of the blade is wholly wanting.

FIG. 7.

In the study of this apparatus I have been very much interested to note how persistent is its type within each family. I have carefully examined very numerous specimens, and I think we could, from the study of this organ alone, arrange the species of Hymenoptera, with very few exceptions, in their respective families. The same is also true in many cases of genera. We shall not wonder at this as we come to study the function of the organ and note its great importance.

No one who has studied bees closely can doubt for a moment the functional importance of the antennæ. As touch organs, they are most delicate and wonderful. The work of the hive bee is largely performed in total darkness. Yet very intricate operations are carried on with unerring exactness. This is only possible through the aid of those very sensitive tactile organs—the antennæ. There is hardly less doubt that the antennæ are the scent organs of insects. And with Hymenopterous insects, especially of the higher families, the sense of smell is of exceeding importance. It has been thought also that the antennæ serve as organs of hearing. This, however, is probably not true. We see then that it is of the highest importance that these organs be kept free from all dust. But the very habits of most Hymenopterous insects, visiting, as they do, flowers laden with pollen, as do all except the lowest families, or digging in the mud and dust, as do many bees and wasps, tend to soil the antennæ. And it is no more necessary for the microscopist to brush the lenses of his objectives than for the bee or wasp to dust its antennæ.

That the function of the apparatus just described is to brush or free from dust the antennæ is easily proved by experiment. We have only to imprison a bee or wasp on the window pane of our room, and quietly dust its antennæ with lime or flour, when we will see it pass an anterior leg forward, draw an antennæ through the

cleaner, after which the bee will pass the fore legs, now foul with dust, between the brushes formed by the soft hairy inner faces of the basal tarsi of the middle legs. This will be repeated several times, when upon examination the antennæ will be found entirely freed from the troublesome dust. In case of the wasp, as *Polistus annularis*, the antennæ are cleaned the same as just described except that the leg or antenn cleaner is cleanedæ by passing it between the jaws instead of between the middle legs. As we are sure of the function of this beautiful apparatus we do not need to refer to the wonderful correspondence in size of the cavity in each separate case, with the antennæ of the same insect, which would be added proof if such were needed as to its function. I will also state that I believe I have found an antennæ cleaner in some beetles, especially carabids. In these cases the cavity and lid are both on the tibia a little distance towards the body from its farther end.

In the honey-bee on the outer end of the tibia, just opposite the antennæ cleaner (Fig. 1), is a small brush. This has been regarded by some as a cleaner of the antennæ cleaners; but we have seen that the latter organs are cleaned in another way. I have never seen these brushes used to clean the cavities, though I have observed closely. The fact that other bees, wasps, ants, etc., have no such brush makes me doubt such function.

The branching, fluffy hairs which cover the upper part of the fore leg (Fig. 1) of the worker honey-bee are like the same in other legs of the same insect, of use in gathering the pollen. From these hairs the pollen is combed off and transported to the pollen baskets.

Opposite the side of the basal tarsus which contains the cavity of the antennæ cleaner of the bee (Fig. 1), is a comb formed of quite stiff hairs. This is used to free the hairy compound eyes of the bees of dust, pollen, etc., and also to comb the pollen off the lighter hairs. The former function may be observed by closer observation, as the bee is seen to wipe its pollen-begrimmed eyes, much as the common house fly is observed to rub its eyes, face and antennæ.

The middle legs of bees are covered with the compound hairs to the end of the tibia where a prominent tibial spur (Fig. 8) is seen, but no more prominent in the honey-bee than in other bees and in wasps. Indeed it is even larger in drones than in the

FIG. 8.

worker bees. It has been claimed that this is the lever with which the bee pries off the pollen mass into the cell; but the fact that these are no more prominent than in other insects where there is no such function to be performed, and the fact that the stiff hairs which point outward at the ends of these and all the legs are better fitted for this work, gives reason to question the accuracy of this view. On the inside of the first tarsal joint of the middle legs (Fig. 8) is a fine brush thickly set with hairs, which, as we have already seen, is used to clean the antennæ cleaner, and, as I often noticed large masses of pollen adhering to this brush, I am led to the conclusion that these are hands or claspers that aid to bear the pollen to the baskets on the posterior legs. The lower or outer hairs of this brush are spine-like and doubtless aid as already suggested in pushing the loads of pollen from the legs into the cells of the comb.

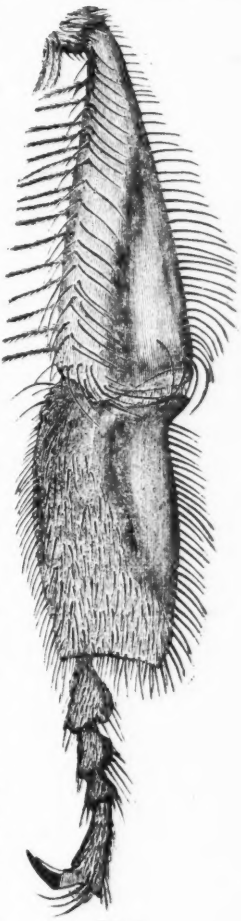

FIG. 9.

Upon the first three joints of the posterior legs, the coxa, trochanter and femur (Fig. 10) the soft, compound, polen gathering hairs are well shown. In the honey bee the tibia and first tarsus ars wonderfully developed. On the outside (Fig. 9) are cavities for holding the pollen. These shallow cavities, one in each of the joints, are bordered with course hairs, which serve as so many stakes to aid in holding the large pollen masses which the bee is often seen carrying to the hive. Opposite the concavity of the tarsal joint (Fig. 10) on the inside are to be seen nine or ten rows of beautiful yellow hairs, which form as many combs or brushes, which serve to collect and transport the pollen from different parts of the bee to the pollen baskets. If a bee is captured while collecting pollen,

these beautiful brushes will always be found with more or less pollen adhering to them. Of course the combs of one leg are used to fill the pollen basket of the opposite legs. As before stated, this work is in part performed by a similar but less perfect arrangement on the corresponding portion of the middle legs.

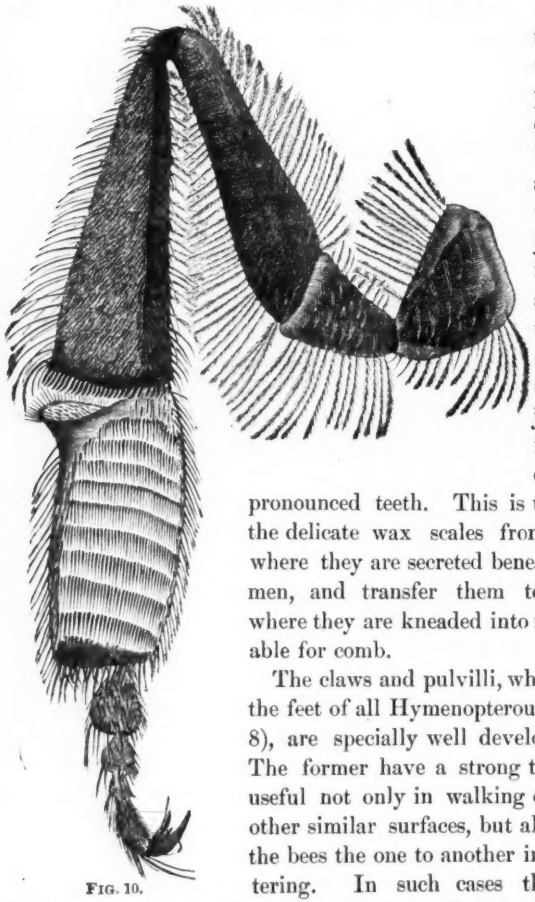

FIG. 10.

Between the tibia and first tarsus of the posterior legs of the honey-bee (Figs. 9 and 10) is a very curious joint, reminding one of a steel trap or the jaws of an animal, the tibial or inner jaw of which is well covered with quite pronounced teeth. This is used to grasp the delicate wax scales from the pockets where they are secreted beneath the abdomen, and transfer them to the mouth where they are kneaded into material suitable for comb.

The claws and pulvilli, which terminate the feet of all Hymenopterous insects (Fig. 8), are specially well developed in bees. The former have a strong tooth and are useful not only in walking on wood and other similar surfaces, but also in holding the bees the one to another in case of clustering. In such cases the uppermost have to sustain hundreds of their fellows, and this often for hours. There are few better examples in the whole animal kingdom of what may be accomplished by mere muscle.

The pulvilli are situated between the claws. They are large and glandular, and by secreting a viscid adhesive material enable a bee to walk up a smooth surface like that of glass. We thus understand why a bee fails in its attempt to walk up a moistened or powdered glass surface. When a bee walks on wood the pulvilli are turned back, when on glass the claws are similarly made to change their position.

DIRECTIVE COLORATION IN ANIMALS.

BY J. E. TODD.

MUCH has been written by Wallace, Darwin and others concerning the protective effects of coloration in animals, and this adaptation perhaps accounts for most of the chromatic characteristics of animals. Darwin has also shown how many may be accounted for by sexual selection, and Wallace has referred many of those, still remaining unexplained, to the play of color-producing forces uncontrolled by natural selection.

So far as the author is aware, however, there has been no distinct enunciation of the principle sketched in the following pages. The nearest approach to it is a remark of Darwin in regard to the rabbit's white tail—that it might serve as guide to the young in following the old ones to the burrow; and another—that the stripes of the zebra may be of use to stragglers in recognizing their fellows at a distance. (Vide AM. NAT., 1877.)

Wallace approves the suggestion, and, from some notes of his recent Baltimore lectures, it may be inferred that he has carried the principle further. But in their published writings both these eminent naturalists refer several distinct cases to other sources, which in the following pages will be claimed as examples of what, for want of a better name, we have styled *directive coloration*. And whether the views hereinafter to be advanced prove to be entirely novel or not, they have, so far as here expressed, sprung entirely from the author's own observation and study. He regrets that both have necessarily been so limited that he cannot multiply examples as freely as nature has supplied them. What is here offered is only a sketch of what might be wrought out by any one having time to carry out the work in its details.

The first observations which eventually proved the germ of this paper were made on the plains of Dakota. During the long, monotonous rides over that region, one pleasant circumstance was the sudden rise of various birds from the nearly naked ground and their as sudden disappearance on lighting. Ere long it was noticed that in the process of lighting there was, very commonly, a conspicuous flashing-out of white on wings or tail, or on both. This was noticed in several of the sparrows, the meadow-lark, the lark-bunting, the Carolina dove, and less prominently in the prairie-hen or grouse. Somewhat similar facts were noted also of the jack-rabbit and antelope. The question then arose, very naturally, Why is this prevalent character? Of what advantage is it? For the smaller birds, the answer came readily. The plains are constantly scoured by hovering hawks —therefore, protective coloration is of prime importance. If, however, they should become of a uniform gray color all over, they would be as completely and constantly hidden from their friends as from their foes. That would be quite disastrous, especially where the former are fewer than the latter. To prevent such a result, there is the following arrangement. When at rest, or about the ordinary occupation of feeding, the gray surface only is exposed; the same is true also in some cases during flight; but in checking its velocity for lighting the tail is fully spread, exhibiting the conspicuous colors fully, and marks the location of the leader, that the rest may govern themselves accordingly. To escape the hawk, should he happen to note the location, the sparrow resorts to doubling on its course and skulking. When the danger has passed, the flock, if they have followed the leader, are likely to be within call of one another, and if they have become too much scattered, this same automatic telegraphy must assist much in enabling the stragglers to find their fellows. Some species, as the meadow-lark, have a habit of spreading the tail at almost every chirp. This would seem to work as rationally as the rallying-call of the bugle and the waving of a flag to call a troop together. Yet after all, in the bird it is doubtless mainly automatic, the effort of the cry producing the twitch of the tail, as truly as in the prairie-dog.

But this conspicuous flash tells more than the place of alighting. It reveals the species at hand. These white patches form a kind of natural heraldry among the denizens of the plains, by which each kind is recognized by friend and foe. Its vivid white secures

its utmost efficiency. It is, no doubt, often useful also at night, whenever there is any disturbance by storm or prowling enemy. Thus far, we have had in mind only the ordinary gray birds and animals of the plains, upon which the directive coloration is almost invariably white. But the principle extends farther. When the general coloration is white or light, the directive color is black or dark, as in the pelican, white crane, weasel, etc. In some which may be gray in summer and white in winter, both white and black may be found in close juxtaposition. In a very few, black seems to serve the purpose, even with gray plumage, as in the horned lark and some sparrows (?). The principle may include also cases where more brilliant tints than those of the white-black series are employed.

Soon after our interest had been awakened in the cases already mentioned it was our privilege to examine a large collection of skunks which some fortunate trappers had captured. The striking white lines on the black ground and their fantastic and very variable forms raised again the question, *Why?* Our idea of directive coloration found a new direction for its application, and it readily suggested satisfactory answers to the query. Here were animals living constantly in dusk and darkness. The conspicuous tail, as Belt remarked long ago, may be classed as a warning signal, and therefore protective; but why the elaborate white lines and spots? These are only useful at shorter distances, and, therefore, presumably to fellow-individuals of the same species. We can readily understand how they may clearly reveal not only the general position of the body, but also its attitude; and by the individual variations in the breadth and continuity of the lines, individuals may recognize one another at night, or in their burrows. In short, these directive markings are in this case what signal-lights or flags are to vessels and cars, Similar reasoning accounts for the markings prevalent in the raccoon. badger, chip-munk, and other burrowing animals. So, too, it accounts for some of the markings about the heads of the sparrows, larks, ducks, and numerous other birds; also, about the muzzle, ears and throat of antelope, deer, hares and other mammals, whether protectively colored or not. These markings are more distinct and more frequent about the head, because of its greater expressiveness and importance. Of course, in this general outlining of our idea we need not attempt to classify rigidly particular markings, for some

may be useful in more than one way. For example, the ears of the jack-rabbit may serve to notify his fellow of his presence at a distance, and when close at hand they, doubtless, are very expressive of the bodily position and mental condition of their owner.

Looking now over the whole animal kingdom, so far as the more comprehensive works on natural history and more careful descriptions of our local faunas will allow us, we find a vast number of spots and lines about the head, shoulders, flanks and tails of animals belonging to all the so-called sub-kingdoms; and we find in our theory a plausible explanation, in harmony with the workings of natural selection.

We find some, however, which, while properly associated with the cases already described, do not come under either of them exactly. Hitherto we have considered where only a few individuals were concerned and only in the casual relations of ordinary life. There are cases where large numbers herd together, oftentimes moving rapidly in crowded phalanx or disorderly mass, where each must closely regulate his movements according to the action of his immediate companions if he would avoid collision and injury. Not only is this important in diurnal travels, but in the nocturnal bivouac, and especially in a stampede at night. In this way we may explain the stripes of the zebra, koodo, etc., and the numerous bright and extended markings on the various African antelopes. It would seem that the greater and more ferocious carnivores of the tropics might have an influence to intensify these features. The bright markings of hyenas and the hunting-dogs are other conspicuous examples, traceable to quite a different combination of circumstances. Less striking marks, which we have noted under another head, may be also helpful in the way just described. For instance, the markings about the head and tail of wild geese and ducks and the black tips of the wings of pelicans may assist them much in keeping their regular order of flight; so, also, the markings upon sparrows, which are helpful in the ways already indicated, during their summer-life may also be of service during their migrations by helping them to harmonize their movements.

It will be seen by a moment's thought that most of the markings helping to show the position of the body may be of pre-eminent value during courtship, especially during the supreme moments of coition. It would not be strange if this advantage might have a tendency

to intensify certain lateral and caudal markings, or even to produce in them sexual differences. We should naturally expect this to be as manifest in nocturnal animals as anywhere. To this cause we are disposed to refer the different colors of the wing-spots of night-hawks and other Caprimulgidæ: In the males they are white, while in the females they are rufous. Possibly, some of the cases which Darwin considers the results of sexual selection transferred from the male to the female may be referred to this influence.

Another relation may, presumably, modify directive coloration to a considerable degree, especially in animals which, though roving the fields themselves, secrete their young. Deer, swine, lions, etc., may be taken as examples of this. The vivid markings upon the young may assist much in the care which the mother gives in the dim light of the hiding-place and at night. This explanation does not necessarily conflict with the more commonly received opinion —that they are the effect of heredity, revealing the coloration of some remote ancestor. It suggests, rather, the further inference that that ancestor was either gregarious and living on open plains, or else was more solitary and prowling, skulking in dim lights. Our theory would offer a rational explanation for its persistence in the earlier stages of living species.

It will be noticed that we have drawn our illustrations entirely from the mammals and birds. We would not imply that our theory is limited to these. Insects, fishes and reptiles may afford equally good examples.

We would remark, in conclusion, that this sketch does not attempt to give details more than may be necessary to present our view intelligibly. Of course, we recognize the validity of the theory of typical coloration consisting of those primal tints and patterns which have been ascribed to the combined action of chemical, physical and vital forces only; also the theories of protective and ornamental colorations, which have been evolved from the typical by the action of natural and sexual selection. We do not profess to be able to refer every tint and pattern of coloration to its predetermining condition or advantage. That would be well-nigh impossible. But if enough has been given and with sufficient discrimination to satisfy most minds, that adaptation for directive purpose is a real advantage which has been decidedly effective in determining the coloration of animals we are content.

A Synopsis of Directive Coloration in Animals.

Directive coloration is that which is in any way useful to a species by assisting in mutual recognition between individuals, or by indicating, one to another, their attitude of body and probable movements.

1. Marks and tints, promoting recognition at a distance, to guide in straggling flight and to bring stragglers together. [A.]

2. Those indicating the attitude of the body and its probable movement [B] in darkness of night, or in dens; [C] in close movements of large numbers, by day as well as by night; [D] in intercourse of the sexes; [E] in the care of young.

A. [a] By having the general color more or less strikingly contrasted with the environment.—Crows, buzzards, blue-birds, woodpeckers, etc.

[b] When general color is inconspicuous: by having striking colors upon parts of the body which may be hidden during rest, but capable of display automatically either during flight, at the moment of stopping, or during a calling cry, viz.:

Conspicuous colors about the tail:—[Mammals] Rabbit, deer, prong-horn, many antelope, Rocky Mountain sheep, chamois, etc., etc. Outer tail-feathers conspicuous:—[Birds] Snow-bird, meadow-lark, many finches, robin and many thrushes, most warblers, many vireos, night-hawk, ptarmigan, horned-lark, etc. A terminal band: Turkey, king-bird, and many fly-catchers, turtle-dove and other pigeons, grouse, etc. Under-coverts: Prairie-hen, coot, galinule, many snipe, many ducks and geese, etc. Rump and upper coverts: Hawks, flickers, and other Picariæ, most geese, etc.

Conspicuous colors about lateral appendages:—In Mammals, the ears (more frequently on the back side)—hares, deer, etc.; in Birds, the wings—many finches, coots, upland-plover, pelican, snow-goose, crane, many warblers, vireos, etc.

B. [a] By striking marks about the head and neck:—[Mammals] Raccoon, badger, skunk, coatis, many antelope and rodentia, etc. [Birds] Many raptores, sparrows, fly-catchers, warblers, anseres, etc., etc.

[b] By various spots and lines on shoulders or sides:—Skunks, chip-munks, antelope, peccaries, chevrotains, etc.

[c] By paleness of belly and inner side of legs:—Cases too numerous to name.

C. [a] Not only by many of the markings already described, but especially by more vivid and extensive marks upon the shoulders, sides and flanks:—Zebra, wild asses, antelope, giraffe, hunting-dogs, etc.

[b] By special marking of the legs and feet upon the outside:—Zebra, antelope, etc.

D. [a] By most of the lateral and caudal markings already mentioned.

[b] By different colors, according to sex:—Night-hawks and other Caprimulgidæ.

[c] By difference in extent or shape of markings, according to sex:—Antelope, etc.

E. By various spots and lines, appearing only in the younger stages:—Deer, some swine, some Felidæ, etc.

SYNOPSIS OF ROSENBUSCH'S NEW SCHEME FOR THE CLASSIFICATION OF MASSIVE ROCKS.

BY W. S. BAYLEY.

ACCORDING to the new scheme for the classification of massive rocks, proposed by Professor H. Rosenbusch of Heidelberg in the second edition of his "Mikroskopische Physiographie der Massigen Gesteine," these are divided into three great groups, (I) intrusive rocks, (II) vein rocks, and (III) effusive rocks. The fundamental notion underlying this classification is briefly as follows: the structure possessed by rock masses as we find them in the earth is dependent upon two circumstances—(1) the chemical composition of their original liquid magmas, and (2) the conditions under which these magmas cooled. The effect of chemical composition upon the structure assumed by a rock magma in its passage to a solid state has not been definitely ascertained. Results recently obtained by Lagorio, however, indicate that the composition of the unsolidified portions of rock masses, exerts much more influence upon the final structure of the rock than has hitherto been supposed. The rapidity with which a rock cooled, as well as the conditions under which this took place, have long been known to be quite influential in determining its structure. Those rocks which cooled

slowly under great pressure and at great depths, where crystallization was gradual and undisturbed, assumed a granular aspect. Those which cooled quickly under low pressure became glassy. Those which began to crystallize in the depths of the earth, and continued their crystallization after the transference of their entire mass to other places, took on a porphyritic habit. Since, then, the structure of a rock indicates with some degree of certainty the prevailing conditions under which it was formed, it affords a convenient basis for the foundation of rock classification. And further, since the conditions under which a rock is formed are directly connected with its geological relations to surrounding rocks, the most logical classification is that which takes primarily into consideration these relations as the causes which produce the effects noted as structure.

Rosenbusch begins, then, by separating all massive rocks into the three great groups mentioned above. The intrusive or plutonic rocks are those which formed at great depths (Tiefen-gesteine); the effusive or volcanic rocks are those which flowed out upon a land surface and there solidified (Erguss-gesteine), and finally the second group, the vein rocks, are those which have been found only in veins or dykes in other rocks, and which may or may not be connected with the effusives.

Before discussing the classification in detail it will be necessary to define a few terms introduced by Rosenbusch to facilitate the description of the more prominent structures characterizing rocks, as we find them to-day.

A rock composed entirely of crystalline minerals is said to be *holocrystalline*. When it consists entirely of an unindividualized, structureless mass, it is known as *amorphous*. When it is partly amorphous and partly crystalline, *i.e.*, contains crystals in a hyaline ground-mass, the structure is described as *hypocrystalline*.

An *idiomorphic* mineral is one whose form is determined by the crystallizing forces acting within itself. An idiomorphic mineral is bounded by crystal planes. An *allotriomorphic* mineral is one which possesses a form due to the action of external forces, and not to the action of intramolecular forces. An allotriomorphic mineral is not bounded by its own crystal planes. Of two contiguous minerals in a rock, one idiomorphically developed, and the other allotriomorphically developed, the former is the older, compelling

the latter to assume a form which it would not do were it free to obey the forces at work within itself, tending to bound it with certain definite crystal planes.

A mineral is described as occurring in but *one generation* in a rock when all of its individual members have separated out continuously in the same interval of the rock's formation. When a portion of the individuals have separated out during one interval, and then, after other minerals have crystallized, another portion has separated, the mineral is said to occur in *two generations.*

When the constituents of a rock occur in but one generation, the rock is *granular* in structure. When but a small portion of these are idiomorphically developed, the rock is *hypidiomorphically granular.* When a relatively large portion or all of the constituents are idiomorphically developed, the rock is *panidiomorphic.* When none of the constituents are so developed the structure is *allotriomorphically granular.*

A *porphyritic* rock is one which contains one or more minerals in more than one generation.

I. Intrusive Rocks.

The intrusive or plutonic rocks are those which were formed at great depths. They were intruded between other rocks which existed before them, either as bosses or sheets, which never reached the surface, or they are the deep-seated portions of large masses which may have flowed out upon the surface of the earth. They may have been formed at any geological age, but are only found in the oldest portions of the globe, because only in these portions has sufficient time elapsed to allow of their exposure by erosion.

They are characterized by the possession of a hypidiomorphic granular structure, although in certain cases, where these rocks were intruded as flows between others, they sometimes tend to the panidiomorphic development.

They are divided, according to their chemical and mineralogical compositions, into eight families.

A. THE GRANITES.

The granites are composed essentially of quartz and an alkaline feldspar, and one or more of the minerals of the mica, amphibole or pyroxene groups, sometimes tourmaline, and almost universally certain apatite, zircon and iron oxides.

They are divided into three divisions, as follows:—

1. TRUE GRANITES, containing both light- (muscovite) and dark-colored micas (biotite, etc.), including
   (A) *lithionite granite*, in which the dark ingredient is a lithium mica.
   (B) *luxullianite*, in which tourmaline replaces the lithionite.
2. GRANITITES, containing a biotite as its only micaceous constituent, including
   (A) *lithionite granitite*, with a lithium mica as the prominent micaceous constituent.
   (B) *amphibole granitite*, containing an amphibole in addition to biotite.
   (C) *augite granitite*, in which an augitic mineral is present.
3. AMPHIBOLE GRANITES, containing amphibole in place of the biotite of the granitites.

B. THE SYENITES.

Syenite differs from granite in the entire or almost entire absence of quartz as an essential constituent. The syenites besides contain no primary muscovite, but do contain a greater or less amount of plagioclase. The alkaline feldspars embrace, in addition to orthoclase, both albite and anorthoclase to a subordinate degree.

They are divided into:—

1. TRUE SYENITES, or hornblende syenites, composed of orthoclase, hornblende, and usually a little biotite.
2. MICA SYENITES, which often contain albite in addition to orthoclase and biotite.
3. AUGITE SYENITES, in which a monoclinic augite and orthoclase constitute the essential components.

C. THE ELÆOLITE SYENITES.

The elæolite syenites are quartz-free combinations of orthoclase and elæolite with one or more of the iron-bearing minerals of the pyroxene, amphibole or mica groups. With these is almost always associated some plagioclase and a greater or less amount of sodalite.

Their structure, though usually granular, sometimes becomes porphyritic through the occurrence of feldspar, elæolite and sodalite in two generations. It is probable that this structure is con-

fined to the outer edges of large masses and dyke forms of the kroc. The various occurrences of elæolite syenite are not well enough characterized to admit of a further classification.

D. THE DIORITES.

The diorites may be defined as rocks composed of plagioclase and biotite or hornblende, with or without quartz. Orthoclase and microcline sometimes accompany the plagioclase, and in certain cases augite partly replaces the biotite or hornblende. The structure of the diorites departs somewhat from the typical structure of the intrusive rocks in that the plagioclase and the biotite, amphibole and augite are sometimes idiomorphically developed.

The diorites are divided into:—

1. MICA DIORITES, in which biotite predominates over hornblende, including
   - (A) *mica diorite*, which is quartz-free.
   - (B) *quartz, mica diorite*, which is quartz-bearing.
2. DIORITES, in which hornblende is the most prominent colored constituent, including
   - (A) *diorite*, and
   - (B) *quartz diorite.*
3. AUGITE DIORITES, containing a large amount of augite, including
   - (A) *augite diorite*, and
   - (B) *quartz-augite diorite.*

E. THE GABBROS.

The gabbros are combinations of plagioclase and a monoclinic or an orthorhombic pyroxene, with or without olivine.

Their structure varies slightly from the typical granular structure, in that the plagioclase occurs in broad lath-shaped crystals.

They are divided, according to the nature of their pyroxenic constituents into:—

1. GABBROS, which contain, as their pyroxenic constituent, diallage, or a monoclinic augite with a composition approaching that of diallage.

   The gabbros include

   (A) *gabbro* proper, which is olivine-free, including two varieties:

(*a* 1) hornblende gabbro, in which diallage is partly replaced by hornblende, and

(*a* 2) hyperite, containing a little olivine and some orthorhombic pyroxene.

(B) *Olivine gabbro*, olivine-bearing.

2. NORITES, which contain an orthorhombic augite as the principal pyroxenic component.

The norites are divided, according as to whether they contain olivine or not, into

(A) *norite*, and

(B) *olivine norite*.

F. THE DIABASES.

The diabases are composed essentially of plagioclase and augite, with or without olivine and quartz.

They form a well-marked class among the intrusive rocks, which differs in many respects from the other intrusives, and approaches very near in characteristics to some of the effusives. This is due principally to the fact that the diabases occur as dykes and intruded layers between sedimentary beds, and thus tend to assume in some degree the structure possessed by sheets which have cooled on the surface under atmospheric pressure alone. They are frequently accompanied by tufas, and they often possess amygdaloidal upper surfaces. Since, however, the pressure under which they were formed was much greater than that under which the volcanic rocks were produced, and, as we may suppose, their cooling much more gradual, the diabases are holocrystalline and hypidiomorphic-granular, as distinguished from the hypocrystalline and porphyritic structures of the members of the effusive class. Nevertheless, the tendency of the plagioclase to assume idiomorphic forms is so strong that an approach to the porphyritic structure is noticeable in many diabases. As among the gabbros, the first differentiation of the diabases is dependent upon the presence or absence of olivine as an essential constituent.

1. DIABASES are olivine-free combinations of plagioclase and augite, usually with a little hornblende and mica.

(A) *diabase* proper contains no quartz.

(B) *quartz diabase* contains quartz as a primary component, including

(*b* 1) sahlite diabase, which contains an idiomorphic colorless monoclinic pyroxene (sahlite), and

(*b* 2) enstatite diabase, containing an orthorhombic augite.

(c) *teschenite* is analcite-bearing.

2. OLIVINE DIABASES contain olivine as an essential constituent in addition to plagioclase and augite.

G. THE THERALITES.

The theralites, formerly called teschenites, are intended to embrace rocks composed of plagioclase and nepheline, together with the accessories angite, biotite and olivine. Rocks of this composition are not known to exist among the intrusives, unless certain basic rocks from Montana, lately described by Mr. Wolff, belong here. Corresponding members of the effusive class are, however, quite well known, and it is therefore expected that true theralites will be found at some time in the future, even if the Montana rocks should turn out not to belong in this family.

H. THE PERIDOTITES.

The peridotites are the most basic of the intrusive rocks. They contain no plagioclase, but usually do contain a large amount of olivine and a mineral of the amphibole or pyroxene families. Their bisilicate constituent is made use of for purposes of sub-classification.

1. PICRITE is composed of olivine and augite.
2. AMPHIBOLE PICRITE contains olivine and hornblende.
3. WEHRLITE consists of olivine and diallage.
4. HARZBURGITE is a combination of olivine and a rhombic pyroxene.
5. LHERZOLITE contains olivine, diallage and a rhombic pyroxene.
6. DURSITE consists of olivine and chromite

II. VEIN ROCKS.

The class of vein rocks includes those which exist as independent geological bodies only in the form of veins or dykes, although many similar rocks occur also as facies of certain intrusive and effusive rocks. This class is not as well defined as either the intrusive or the effusive class. Rosenbusch personally is inclined to place them

with the intrusives, but since no direct connection has been traced between them and deeply buried rock masses, of which they may be regarded as a part, he decides to place them in a separate group until more knowledge of their relations has been obtained.

The structure of the vein rocks resembles in some respects that of the intrusive rocks, and in others that of the effusives. Three well-marked types are recognizable: the granitic, the granite-porphyry, and the lamprophyre. Since these three types can be distinguished macroscopically, and are very characteristic, they are made use of to separate the vein rocks into three groups, which are in turn subdivided into families, according to mineralogical constitution, as in the class of intrusive rocks.

II. A. The Granitic Vein Rocks.

The structure of the granitic vein rocks differs from that of the intrusive rocks, in that their individual constituents tend to become idiomorphic. In most cases this tendency has gone so far as to produce a rock, all of whose components are bounded by their own crystal outlines. They are then panidiomorphic-granular. An approach to the porphyritic development is sometimes the result of a repetition of conditions which allows of the separation of some of the constituents in two generations.

The granitic vein rocks include:—

1. Aplite, or muscovite granite, consisting of orthoclase, quartz and muscovite.
   - (a) *pegmatite* is a coarse-grained aplite.
   - (b) *beresite* is orthoclase-poor aplite.

II. B. The Granite Porphyry Group.

The structure characteristic of this group of rocks is the holocrystalline-porphyritic. Their ground mass is a granular aggregate of crystalline minerals. The predominant porphyritic crystals are light in color, *i.e.*, they are neither iron nor magnesia bearing. The occurrence of iron and magnesia-bearing minerals as porphyritic constituents is exceptional.

The group is divided into:—

A. The granite porphyries.

The mineralogical composition of this family is the same as that

of the granites. The porphyrytic constituents are quartz, orthoclase, and usually one or more of the granitic minerals, biotite, hornblende, augite or muscovite. The same minerals occur also in the ground mass.

No attempt is made to divide the granite porphyries, although it may be convenient to separate them into:—

1. GRANITE PORPHYRY proper, containing no muscovite, and
2. ELVAN muscovite—rich varieties.

B. THE SYENITE PORPHYRIES.

The syenite porphyries differ from the granite porphyries in the absence of quartz from among the porphyritic crystals. In all other respects they are similar to them. Quartz occurs in the groundmass, and plagioclase is more common than in the granite porphyries.

They are divided, according to their principal iron-bearing constituent, into:—

1. HORNBLENDE SYENITE PORPHYRY, which contains orthoclase and hornblende as the most prominent porphyritic constituents.
2. MICA SYENITE PORPHYRY, in which orthoclase and biotite occur in porphyritic crystals.
3. AUGITE SYENITE PORPHYRY, in which augite is the most important non-feldspathic porphyritically developed component.

C. THE ELÆOLITE SYENITE PORPHYRIES.

The elæolite syenite porphyries usually contain elæolite as the most important porphyritic constituent after orthoclase. In one or two cases the elæolite is found only in the groundmass. Rocks belonging to this family have not been sufficiently studied to admit of further classification.

D. THE DIORITE PORPHYRITES.

The diorite porphyrites are not very widespread. They consist of plagioclase, hornblende, and sometimes quartz and biotite as porphyritic crystals in a groundmass composed principally of plagioclase and quartz.

They are divided into families, in accordance with the existence or non-existence of quartz among the porphyritic crystals.

D. *a*. DIORITE PORPHYRITES.

1. DIORITE PORPHYRITE contains plagioclase and hornblende as porphyritic constituents.
2. MICA DIORITE PORPHYRITE contains plagioclase and biotite in porphyritic crystals.

D. *b*. QUARTZ DIORITE PORPHYRITES.

1. QUARTZ DIORITE PORPHYRITE contains plagioclase, quartz and hornblende as the porphyritic ingredients.
2. QUARTZ MICA DIORITE PORPHYRITE. In the rocks of this class biotite takes the place of the hornblende in the quartz diorite porphyrites.

II. E. THE LAMPROPHYRE GROUP.

The lamprophyre group differs from the granite porphyry group of vein rocks in that the iron and magnesium-bearing silicates, hornblende, pyroxene and biotite are the most important constituents occurring in two generations. Their feldspar, which may be either orthoclase or plagioclase, occurs in but one generation.

In composition they resemble the syenites and diorites of the intrusive rocks, and are therefore divided in accordance with this resemblance.

A. SYENITIC LAMPROPHYRES.

The syenitic lamprophyres consist of an alkaline feldspar, biotite, hornblende and pyroxene as essential constituents.

They possess both the panidiomorphic-granular and the holocrystalline-porphyritic structure. The former sometimes passes over into the hypidiomorphic-granular.

They are subdivided according to the presence or absence of biotite as a prominent constituent.

1. MINETTES contain biotite as the principal iron-bearing constituent, both in the granular and the porphyritic forms.
   (A) *hornblende minettes* contain hornblende in addition to biotite.
   (B) *augite minettes* have augite besides biotite as a prominent constituent.

(*b* 1) olivine minette is an augite minette containing olivine.

2. VOGESITES contain hornblende or augite as the most important colored constituent.

(A) *hornblende vogesite.* In this, hornblende predominates over augite.

(B) *augite vogesite* possesses augite in larger quantity.

B. DIORITIC LAMPROPHYRES.

The dioritic lamprophyres differ from the syenitic lamprophyres in containing plagioclase instead of an alkaline feldspar in addition to biotite, amphibole and augite.

Like the syenitic varieties, these rocks are also developed with the panidiomorphic granular and the holocrystalline porphyritic structures.

Their separation into two classes also depends upon the greater or less amount of biotite in their composition.

1. KERSANTITE. This rock is characterized by the possession of large amounts of biotite.

(A) *Aschaffite* contains quartz and feldspar in addition to the iron-bearing minerals in porphyritic development.

(B) *Olivine kersantite* contains olivine in addition to the essential constituents of the kersantite.

(*b* 1) *pilite kersantite,* in which the olivine has been altered to pilite.

2. CAMPTONITE contains hornblende in place of the biotite of the kersantites.

(TO BE CONCLUDED.)

X.—GLACIAL EROSION IN NORWAY AND IN HIGH LATITUDES.[1]

BY PROFESSOR J. W. SPENCER, B.A.SC., PH.D., F.G.S.

I.

DURING the summer of 1886, it was my good fortune to visit the three largest snowfields in Norway, namely, the Folgefond, at the head of Hardangerfjord in southern Norway, whose area is 108 square miles; the Jostedalsfond, two degrees to the north, beyond Sognefjord, whose area is 580 square miles, and the largest snowfield in Europe; and the Svartisen, extending from just inside the arctic circle for forty-four miles northward. All of these snowfields send down glaciers to within from 50 to 1,200 feet of the sea. These snowfields are not basins like those in the Alps, but are mantles covering the tops of plateaus from 3,000 to 5,000 feet or more above the tide, from which great cañons suddenly descend to the sea, and extend themselves as fjords, from 1,000 to 4,000 feet in depth.

Many of the Norwegian glaciers are rapidly advancing. In their progress they do not conform to the surfaces over which they pass, but are apt to arch over from rock to rock and point to point, especially as they are descending the ice-falls. Thus are produced great caverns into which the explorer can often wind his way for long distances.

Beneath the glaciers of Fondal, Tunsbergdal, and Buardal, in the northern, north-central, and south-central snowfields of Norway, as well as under other glaciers, I observed many stones enclosed in ice, resting upon the rocks, to whose surfaces—sometimes

[1] Read before the Royal Society of Canada, May 25, 1887, and the American Association for the Advancement of Science, New York, Aug. 1887. Printed from advanced sheets of the Proc. Roy. Soc. of Canada. See also "The Erosive Power of Glaciers as seen in Norway," Geol. Mag., London, Dec., iii., vol. iv., 1887, and "Ice Action in High Latitudes," ibid., vol. v., 1888, by Prof. J. W. Spencer, M.A., Ph.D., F.G.S.

flat, sometimes sloping steeply—they adhered by friction, and by the pressure of the superincumbent weight. Although held in the ice on four sides, with a force pushing downward, the viscosity of

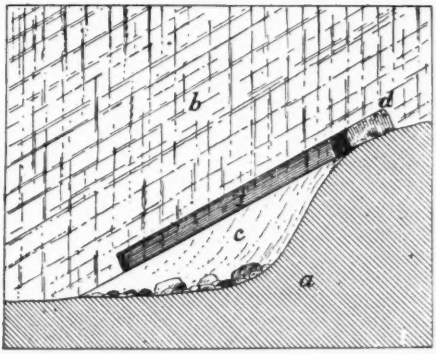

FIG. 1.—Section of Fondalsbræen, *a*, bed rock; *c*, cavern under glacier *b*; *d*, loose stone; *f*, groove under the ice.

the ice, or the resistance of its molecules in disengaging themselves from each other in order to flow, was less than that of the friction between the loose stones and the rock; consequently the ice flowed around and over the stones, leaving long grooves upon the under-surfaces of the glacier. The first observation made was at Fondals-bræen (Fig. 1), where an angular stone (Fig. 1 *d*) whose section was ten by eighteen inches, rested upon the sloping face of smooth rock (*a*). For twenty feet below the stone, the under-surface of the glacier was grooved (*f*) by the moulding of the ice about the obstacle. This distance showed the advance of the glacier after the stone had come in contact with the rock, for it had evidently been completely buried at the lower end of the groove, before the ice had begun to flow about it. As the ice between the stone and the rock gradually disappears, the embedded stone does not suddenly cease to move, but drags, until enough of the surface rests upon the rock to allow of friction between the two granitoid surfaces to overcome the viscosity of the ice, when the latter flows around the obstacle. Elsewhere, an example was seen of this action. The knife edge of a wedge-shaped piece of gneiss was protruding beneath the ice and resting upon the rock. The front end of this stone had moved beyond the subjacent surface, while the posterior

end was still upon it. Yet the sharpness of the edge had scarcely been blunted.

Abundant examples were found to show that the flowing of the ice about loose obstacles was quite the rule. Both large and small (even an inch in length), angular and rounded masses, lying either upon the rock, or upon morainic matter, were sufficient to channel the bottom of an advancing glacier. No blocks of rock were seen in the act of being torn loose from the floor or sides of the valley, and certainly there were no loose or solid masses being picked up by the advancing glacier.

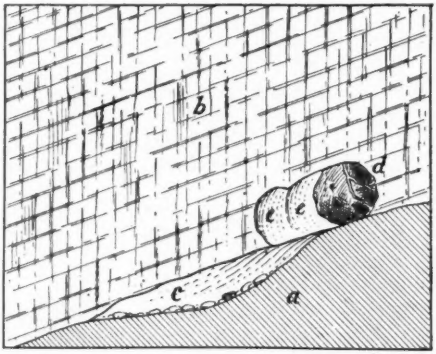

FIG. 2.—Section of Tunsbergdalsbræen, *a*, bed rock; *c*, cavern under ice *b*, *d* boulder; *ee*, moulding in ice of the form of *d*.

At Tunsbergdalsbræen (Fig. 2), whose lower end is 1,600 feet above the sea, a modification of the above described phenomena was seen. A roughly rounded boulder (Fig. 2 *d*) of thirty inches diameter was enclosed in the convex side of the glacier, which rose above it from thirty to forty feet in height. It was resting upon a surface, sloping at a high angle, and was held in place by the ice itself. As the surface of the stone, bearing upon the rock, was small compared with that held in the ice, it should have been dragged along. But it was being rolled, as shown by the moulding (*e e*) of its form in the glacier which was advancing faster than the stone was rolling down the steep slope. The pressure upon this stone could not have been merely that of the superincumbent ice, a few feet thick, but also that of a powerful component of the weight of a glacier from 1,500 to 2,000 feet high descending more or less

like a fluid. The energy upon the boulder was sufficient to crush it into one large and two smaller masses, together with stone dust. When seen, the three fragments had hardly begun to part company.

The abrasion of the solid rock by the fall of stones, and detached masses of ice and stones, was illustrated at the locality just named. The two guides and myself succeeded in detaching a large boulder of about five tons weight, adjacent to the edge of the glacier. It went rolling and sliding down a hundred feet or more, tearing away great blocks of ice which held a considerable amount of debris, and in its wake, the rock was more or less crushed or scratched.

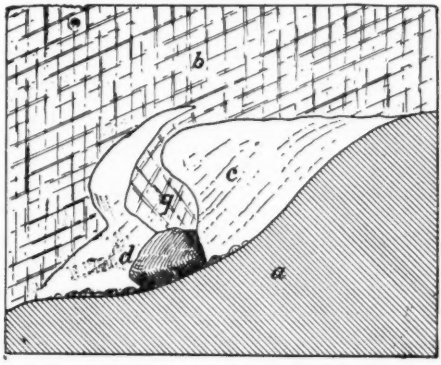

FIG. 3.—At Tunsbergdalsbræen, *d*, a loose boulder, resting on rock *a*, in cavern *c*, against which a tongue *q*, of the moving glacies *b*, impiges and is bent backward.

A further example of the ability of the ice to flow like a plastic body was shown in a cavern (Fig. 3 *c*) 400 feet higher than the end of the glacier, where the temperature was 4°C., while that outside was 13°C. Upon the debris of the floor rested a rounded boulder (*d*) whose longer diameter measured thirty inches. A tongue of ice (*q*), in size more than a cubic yard, was hanging from the roof, and pressing against the stone. In place of pushing the stone along or flowing around it, the lower layer of ice above the tongue had yielded, and was bent backward as easily and gracefully as if it had been a thin sheet of lead, instead of one of ice a foot thick.

According to the experiments of Herr Pfaff,[1] the temperature of

[1] Nature, Aug. 19, 1875.

ice has a great deal to do with its flow about obstacles. Below freezing-point, the movement is scarcely more than appreciable, while above that point, but not below, it may reach twenty-eight inches a day, or more. The conditions arising from the temperature beneath the glaciers are more or less favorable for the movement of the ice, as the lower surfaces are never entirely below freezing-point, even in winter. Professor S. A. Sexe[1] found that the water flowing from a Folgefond glacier, in February, 1861, had a temperature of 1°R., whilst that of the air was 7°R. below freezing-point.

The movement or flow of the ice about detached stones, resting upon rocks, has been observed by Professor Sexe beneath the Buarbræ, and by Professor J. W. Niles beneath the Aletsch glacier.[2] Professor Sexe illustrates the moulding of the ice about a loose stone, which was held beneath the glacier by a projection of the rock. My observations were upon stones, not held up by rocky projections, but upon surfaces often sloping downward. Although Professor Niles did not record observations showing that there was definite movement of the stone, yet he concluded that there was a differential movement of the ice and the block. Whatever differential movement there is, it must be very inconsiderable, not only upon horizontal plains, but upon inclined surfaces. In the former case the movement of the ice is reduced almost to zero, as shown by the measurements of Professor Tyndall upon the Morteracht, where the velocity of the surface, some distance from its end, was fourteen inches, whilst that of the tongue of the glacier, as it reached the plain, was only two inches a day.[3]

The most important condition favorable for holding stones in ice as graving tools is low temperature, which impedes its progress; but this condition beneath glaciers does not generally exist. At higher temperatures, the velocity of the glacier is not great enough to overcome its plastic movement and to drag along detached blocks. However, when the whole mass of ice is charged with sand and stones, there is no doubt that polishing and scratching are effected; but when there are only occasional fragments in the bottom of the ice, as is commonly the case, the erosion from the sliding ceases as

[1] Om Sneebræen Folgefon, af S. A. Sexe.
[2] American Journal of Science, Nov., 1878.
[3] Tyndall's Forms of Water.

soon as the resistance due to friction between the stones and the rock equals that due to viscosity, which, as observations show, is soon reached. Consequently, we should not expect to find great troughs or grooves scooped out of solid rock by the actual glacier. These I have not seen about the existing glaciers of Norway, which are not dependent upon atmospheric and aqueous erosion and the texture of the rock, although their surfaces may have been subsequently polished. Generally speaking—as seen in the valley behind Fondalen Gaard, where the glacier is nearly free from sand, and contains comparatively few stones, as well as at many other places—the surfaces of the subjacent crystalline rocks, although of the form of *roches moutonnées*, with angles mostly removed, are not

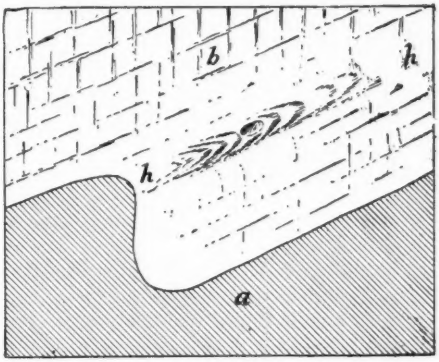

FIG. 4.—Section at Fondalsbræen, *hh*, zone along which ice (*b*) is flowing upon its lower layers.

smooth, but are as rough and as much weather-worn as similar rocks in warmer countries where no glaciers have been. Upon these surfaces, it is often difficult to discover scratches—even when present—for they are often so faint as to be only rendered apparent by moistening the rock. Even the face of the hummocks are commonly imperfectly polished. In other places, particularly at Tunsbergdalbræen which contains much sand along the margin, the rocks are highly polished, and but little scratched. One is everywhere surprised to find beneath the glaciers the great paucity of glaciated stones, and in many terminal moraines they are scarcely, if at all, to be found.

The insufficiency of glaciers to act as great erosive agents is

farther shown at Fondalen (Fig. 4), where a mass of ice thirty or forty feet thick abuts against a somewhat steep ridge of a rock, ten feet or less in height. In place of a stone-shod glacier sliding up and over the barrier, the lower part of the ice appears stationary, or else is moving around the barrier, while the upper strata bends and flows over the lower layers of ice (along the line *hh*, Fig. 4).

When the barrier to the advance of a glacier is met with, whether composed of hard rock, or of morainic matter, the ice, provided it be sufficiently high, flows over upon itself, yet when the sheet is no higher than the barrier, the lateral thrust may push it up somewhat. The best example of the consequences of such a condition is

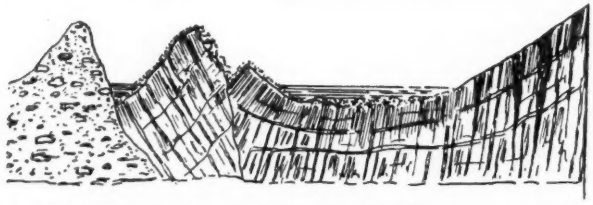

FIG. 5.—End of Svartisen glacier at head of Holandsfjord, moving through a lake against morainic barrier.

to be seen at Svartisen glacier (Fig. 5), at the head of Holandsfjord, which descends to within sixty feet of the sea, where it ends in a morainic lake of considerable size, the northern side of which is filled with the glacier. The water of the lake rises, in part, to the level of the ice, or over it, where the waves of the lake are depositing sand upon its surface. Part of the ice is not less than twenty-five feet thick, and most of it is probably double that thickness. Some of the strata of ice are pushed up and rest at 5° from the horizontal. But the interesting points are at the end of the glacier, where it impinges against the morainic barrier. Being unable to advance, the lateral pressure has forced up an anticlinal ridge or rather dome in the ice, to a height of fifteen feet, along whose axis there has been a fracture and fault. Upon this uplifted dome rests the undisturbed sand stratified in perfect conformity to the surface, which was formerly just below the level of the lake. As the ice about the line of fracture melts, the sand falls over and leaves a sand cone, of which there were examples—one at the end of the lake, and two in the centre—but the nuclei of the mounds were of

solid ice. By this lifting process, pockets of loose clayey sand were thrown on top of the morainic matter, producing thus the appearance of having been ploughed up by the glacier to even several yards beyond its termination, which has not been the case.

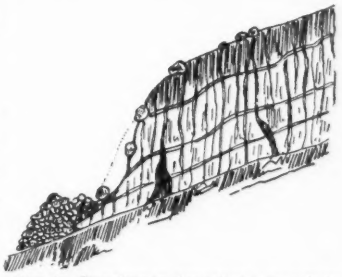

FIG. 6.—Buarbræen depositing morainic material upon a tongue of its ice, giving the false appearance of a glacial plough.

Nowhere is there apparently more ploughing action, and yet little or none to be seen, than at Buarbræ, which is advancing rapidly against a high lateral moraine. There is a large ridge (Fig. 6) of stone upon a thin snout of the glacier, just as if the ice were pushing under the boulders of earth. The glacier has a steep convex margin, from twenty to forty feet high, with many blocks and boulders upon it. These become detached, and, rolling down upon the lower tongues of ice, build up a ridge and leave a deep trough between it and the side of the glacier, and delay the melting of the layer of ice beneath, which is too thin to do any ploughing up of the moraine.

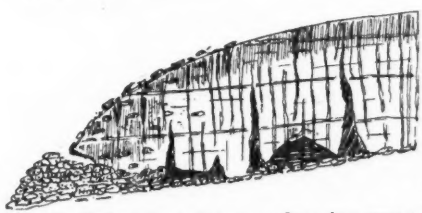

FIG. 7.—End of Suphellebræen advancing over a moraine.

An excellent illustration of a glacier advancing, without any ploughing action, over a moraine, and at the same time levelling it into a sort of ground moraine, was seen at Suphellebræen (Fig. 7). Here the glacier was moving up the slight elevation of a moraine produced by the early summer retreat of the glacier, although again advancing in July. The lower surfaces of the ice-tongue were furrowed by the loose stones of the soft incoherent water-soaked moraine, into which one's foot would sink when stepping upon it. The moraine was being levelled by the constant dripping of the water from the whole under-surface of the advancing glacier.

The glacier of Suphelle is the most remarkable of its kind, being a gigantic *glacier rémanié*. From the Jostedalsfond, which, near

the head of the valley of Fjærland fjord, is 3,000 to 4,000 feet high, the clear, bluish ice falls over a precipice of dark rocks for about 1,000 feet, and at about 1,500 or 2,000 feet above the sea begins to re-form into a glacier extending down into and nearly across the valley of Fjærland for a distance of somewhat less than a mile, to a level of only 175 feet above the sea. The glacier is much crevassed, and covered and filled with debris. In fact, it was the most dirt-laden glacier seen—not excepting the Aar glacier in the Alps. This material is wholly derived from the side of the mountain, and is brought down by frosts, and more largely by the fall of ice as it dashes from one frost-cracked rock to another. One of these great ice-avalanches I witnessed from the other side of the valley, fully a mile distant. Thousands of tons must have fallen at this time, but as the ice fell from rock to rock, it was converted into what, seen at the distance, appeared to be white dust. There are no considerable streams from the upper glacier, but from the rapidly melting glacier below the fall the volume of water laden with mud is large. As this glacier is not ploughing up, but levelling down the inequalities of its bed of loose material, we cannot suppose that the mud comes from any other than the dirt upon and within the ice, and that obtained by the dripping water as it levels the terminal moraine. This is only one of the examples everywhere to be seen showing the erroneous estimate of glacier-erosion, when based upon the amount of mud carried down by the streams flowing from the glaciers; for the debris is brought upon their surfaces by other than grinding action, and, as far as observation goes, it is not derived from beneath them, at least, to any great extent.

Although I have seen some of the sharp angles of the rocks at 2,000 feet above the fjords along the sides of the valleys, somewhat rounded and scratched, yet the inequalities of the faces have not been removed by erosion of any kind. At numerous places in Norway, as well as in other countries, hummocks of rock rise above or out of the glaciers, as the ice flows around them at lower levels, these channels having been deepened, not by glaciers, but by sub-glacial streams.

Nowhere are the *roches moutonnées* so abundant as on the coast of Norway. In their more perfect form, they are not extensively developed along the coast at more than 250 feet above the sea. A

higher altitudes they are best seen about glacier-falls, farther up the valleys. But during the Pleistocene days, the coast has been raised several hundred feet, at least. The form of the hummocks is precisely like what may be seen in southeastern Missouri and other States south of the line of northern drift, or are described as occurring in Ceylon, Brazil and other tropical countries, to which only are added the scratches. The forms of these hummocks must be principally attributed to the atmospheric erosion of the crystalline rocks where the debris has been swept away by currents or by ice. We see them more frequently swept clean upon the coasts of either cold or warm countries than in the interior, where the currents are only those from rain or local glaciers, for even the sweeping beneath the glaciers is principally effected by dripping waters or streams. Professor Kjerulf, of the University of Christiania, than whom there is no better authority, regards the production of hummocks and their glaciation up to a height of 600 feet upon the coast of Norway, as the result of floating ice.[1]

The absence of transported boulders and striations upon the surface of many parts of the high plateaus of Norway is doubtless, in part, attributable to the ability of ice to flow around loose obstacles, and the frequent want of higher ridges to furnish material by their debris falling upon the ice to work through the mass afterwards.

The faith in glaciers, as great erosive agents, has been so severely shaken that few geologists, who personally study those still existing, now attribute to them greater power than that of removing soft materials, and of this power many others are sceptical, *e.g.*, Professor Penck,[2] of the University of Vienna, who has been misquoted as having proved their great efficiency in eroding basins in hard rocks. To this scepticism, it seems to me that these notes must contribute; especially when glacial erosion is applied to the hypothetical excavation or modification of great lake-basins, and the transportation of the northern materials in the boulder clay over the broad plains of America, as there were no mountains of adequate height with peaks, or *séracs*, to supply the detritus sufficient to furnish the tops of the glaciers with all the boreal material of the drift, which "covers half a continent."

[1] Discourse before Meeting of Scandinavian Naturalists, Copenhagen, 1873.

[2] Geological Magazine, April, 1883.

In connection with this paper, the observations of Herr Payer and other arctic explorers are important. The snow-line of Franz Joseph Land descends to within a thousand feet of the sea, and the numerous glaciers discharge great quantities of icebergs as they move down into the ocean. Payer says: "However diligently I look for them, I never saw unmistakable traces of grinding and polishing of rocks by glacier-action."[1]

Lieutenant Lockwood[2] found in central Grinnell Land a thick ice-cap, extending for a distance of from seventy to ninety miles, faced by an ice-wall of from 125 to 200 feet high, irrespective of topographical inequalities. It was free from rock debris, except in a valley confined by mountain-walls thousands of feet high. Along its foot there was almost an absence of morainic deposits, and even where present these were unimportant ridges. The general absence of rock and dirt in the arctic glaciers is a common subject of remark. The snow line in the high latitude of central Grinnell Land is 3,800 feet above the sea, and the glaciation of the rock about the adjacent Lake Hazen (500 feet above tide) is not recent.

In Spitzbergen, where the snow-line is much higher, striated rocks, according to Nordenksjold, occur only below 1,000 feet.[3] The same holds true for Labrador, where the scratches are confined to the lower thousand feet, although the mountains rise to 6,000 (Bell).[4]

In the Antarctic regions, the officers of the "Challenger" remarked the absence of detritus in the icebergs and southern ice, although Wilkes and Ross saw rocks upon a few bergs. These last are supposed to have come from valleys in the volcanic mountains.

Indeed, outside of valleys, explorers in high latitudes have not found, in the margins of such ice-caps visited, the tools capable of great erosion. The continental area of North America presents very much lower and less abrupt prominences than the reliefs of Greenland, Grinnell Land, Spitzbergen or Franz Joseph Land. Overhanging mountains seem to be necessary to supply glaciers with tools by which alone any abrasions can be accomplished, and

[1] New Lands within the Arctic Circle, 1872–74.
[2] Three Years of Arctic Service, 1881–4, Greely.
[3] See Geological Magazine, 1876.
[4] Dr. Robert Bell, in Hudson's Bay Expedition of 1884.

these conditions belong only to valleys of great mountain ranges. However, there is one condition under which glaciers, when shod with graving tools, ought to be great eroders, viz., when their motion is much more rapid than the flow of land ice,—which is almost invariably less than three feet a day, under which condition, included stones commonly adhere by friction to the subjacent rocks, and cause the lower surfaces of the ice to be grooved. This condition of extraordinarily rapid movement has been seen at Jacobshavn glacier in Greenland, where Professor Helland[1] found a velocity of from forty to sixty feet a day. In Alaska, Lieutenant Schwatka[2] and Professor G. F. Wright[3] observed glacier movements of from forty to seventy feet a day. In these cases the glaciers are moving into the sea, and the new element of partial flotation or sliding, which does not belong to land glaciers, is here introduced. The great velocity of these glaciers is far beyond any observed ability of ice to flow as plastic bodies; consequently, one is led to conclude that, under partial flotation, stones may be held firmly as graving tools by glaciers.

Hereby we are able to explain the occurrence, in many Alpine valleys, of a greater glaciation than we see in progress to-day, as being due to glaciers rapidly advancing into fjords, during a period of partial submergence.

The appeal to the greater magnitude of the glaciers, as producing effects not now seen as the result of those of the present day, seems to be begging the question, for the action of thicker glaciers differs from that of thinner in amount rather than in kind; for increased pressure, raising the temperature, increases the plasticity of the ice, as it is seldom if ever lower than freezing point. Consequently it seems improbable that stones should be held more firmly in glaciers of thousands of feet in thickness than in those of hundreds of feet. In addition, the friction between the stones held in the ice, and the surface of the subjacent rock, is proportionally increased by the greater weight of the glacier.

Over the vast area of action, the work of floating or sea-ice, in some forms, is enormous. On the northern side of Hudson Strait,

[1] Ice-fjords of North Greenland, Quart. Jour. Geo. Soc., 1877, A. Helland.

[2] "Times" Alaska Expedition, New York, 1886, Schwatka.

[3] The Muir Glacier, Am. Jour. of Sci., 1887.

Dr. John Rae,[1] who had very extensive arctic experiences, found that snow drifting over precipices into the sea resulted in the formation of bergs, sometimes a hundred feet thick, filled with the loose rock debris of the coast, and having the form of the shore where formed. Most of them break loose and drift away to melt or become stranded elsewhere.

Greely describes the great momentum with which the floe-bergs come together. By their meeting the ice is crushed, and raised up into ridges fifty or sixty feet high.

One cannot read carefully the results of the British Arctic Expedition of 1875–6 without being impressed with the erosive power of drifting ice, moving with a velocity never acquired by glaciers. Floe-bergs are pushed upon a shelving sea-bottom, until the ice has risen from twenty to sixty feet, after their first stranding in perhaps only from eight to twelve fathoms of water, although weighing tens of thousands of tons.[2]

As the grounded floe-bergs are forced up the shelving sea-bottoms, ridges of earth and stones are pushed up in front of them. Floe-bergs which have been toppled over, thus showing their original bottoms, and also masses of pushed-up coast ice are found to be grooved and to contain angular stones with their exposed surfaces scratched and polished. As the movement is greater than the velocity of glaciers flowing about obstacles, it is only natural to expect that the enclosed stones should be held firmly as graving tools, or be wrenched out owing to the brittleness of the ice under such great stress.

In describing the ice action on the coast of Labrador, Professor H. Y. Hind says the "pan-ice" (from five to twelve feet thick) is polishing the surfaces and sides of the rocky coast, and producing boulder clay. He says: "When the pans are pressed on the coast by winds, they accommodate themselves to all the sinuosities of the shore line, and being pushed by the unfailing arctic current, which brings down a constant supply of floe ice, the pans rise over all the low lying parts of the Islands, grinding and polishing exposed shores, and rasping those that are steep-to. The pans are shoved over the flat surfaces of the Islands, and remove with irresistible force every obstacle which opposes their thrust, for the

[1] In Canadian Journal, Toronto, 1859.

[2] British Arctic Expedition of 1875–76, Sir George Nares.

attacks are constantly renewed by the ceaseless ice stream from the northwest, and this goes on uninterruptedly for a month or more."[1] Similar results elsewhere have been frequently recorded, as those of Professor Milne in Newfoundland.[2]

While the power of glaciers, under favorable conditions, to abrade and scratch rock surfaces, as "sand-paper" scratches "a cabinet," is not questioned; yet these observations, in Norway and elsewhere in high latitudes, all confirm the correctness of the verdict given by many geologists—especially in Europe—who have had the opportunity of personally studying living glaciers, that the potency of land-glaciers to act as great eroding agents, capable of "planing down half a continent," or ploughing out great valleys, or lake-basins, or even of greatly modifying them, is not only not proved, but most strongly negatived. Even the power of glaciers to abrade is reduced in many cases almost to zero.

EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

European governments give more attention to the preservation of their ancient and prehistoric monuments than does the United States. This may arise, partly, from the increased interest upon that subject among their officials and people; or, partly, from the differences in our form of government. Whatever may be the cause, our government and our people, unless they improve their present methods in this direction, will find cause for regret in after years, when the prehistoric monuments of our country shall have been destroyed and their contents scattered without a record, when it will be too late to remedy the neglect.

The French government has passed several laws upon this subject. It has established a commission under the direction of the Minister of Public Instruction and Fine Arts, charged with the duty of the supervision of these monuments throughout the Republic. These laws only provided for the procuration of the title to land by gift or purchase. Some of the land-holders took

[1] Notes on Some Geological Features of the Northeastern Coast of Labrador, Can. Nat. 1878.

[2] Ice and Ice Action, Newfoundland, Geol. Mag., 1876.

advantage of this and increased their price beyond what was fair and reasonable, and now the French government has met them with a decree, authorizing the State to acquire by *expropriation* the land on which these monuments are situated, principally in the Commune of Carnac, Department of Morlehan.

Many of the monuments have already been acquired; have been restored to their original condition, surrounded by a fence, where practicable, for the necessary preservation. This has been done under the supervision of M. Felix Gaillard, archæologist of Plouharnel.

Those to be added under the decree, above mentioned, will be the great alignments of Menec, of Kermario and of Kerlescan; the great tumulus of Saint-Michel, that of Moustier, of Crucuny and of Kerlescan. Also six Menhirs and six Dolmens.

It is believed that under the operation of this law the present proprietors will yield, and that the State will acquire, by purchase, all the monuments of this kind within the commune. When these are restored and put in proper condition, this commune will be one of the most attractive in all France, and the American tourist, interested in prehistoric archæology, will feel it as much a necessity to visit it as to visit Paris.—*T. W.*

RECENT LITERATURE.

A Review of Mr. Lydekker's Arrangement of the Mesozoic Mammalia (Cat. Foss. Mamm., British Museum, Part V., 1887).—Mr. Lydekker places all the Mesozoic mammalia among the Marsupialia, not admitting that there is sufficient weight in the close analogy between the dentition of the Stylodontidæ and Chrysochloridæ to support a reference of this family to the Insectivora. The genera included under the sub-order Multituberculata of Cope are provisionally embraced in the Diprotodontia (p. 195,) while all the remaining forms with numerous small incisors are placed with the Polyprotodontia. I agree with the author that the systematic position of the Multituberculata forms, such as Plagiaulax, Tritylodon and Polymastodon must be left, in a measure, provisional until additional material is obtained; but at present, in my opinion, the balance of evidence necessitates their separation from the Diprotodonts. The most striking feature of both these groups is the hypertrophy of a pair of incisors in each jaw; but, so far as a close comparison of these incisors in the fossil and recent forms is

possible, it supports the conjecture that these teeth in the two groups *are neither homologous nor homodynamous*, although bearing a superficial analogy.[1]

(1.) As regards homology, in all the Quaternary and recent Diprodonts it is the median incisor which is hypertrophied; whereas, in the Mesozoic genera—in which the mode of reduction has been observed—the second incisor, or, rather, one of the lateral incisors is hypertrophied. In the Bolodontidæ, as demonstrated by Marsh in his observations upon *Allodon*, the median incisor is reduced and the *second* incisor is hypertrophied. In *Tritylodont* there are two incisors: the outermost is close to the maxillary suture; the hypertrophied incisor is close in front of this and widely separate from its opposite fellow, indicating that if this genus is descended from a form with three or four incisors (as a comparison with Bolodon renders probable), it is again the median incisor which has disappeared. We have no further evidence bearing upon this point, so it will be of importance to observe which of the incisors is hypertrophied in *Plagiaulax*.[2]

(2.) *As regards homodynamy*, another characteristic which appears to be universal among the Multiberculates is the fore-and-aft grinding motion between the alternating rows of tubercles upon the upper and lower molars. This is very marked in *Bolodon* and *Tritylodon;* it is in a transition stage from a fore-and-aft to a circular grinding motion in *Polymastodon;* it is very evident in the later Plagiaulacidæ. Professor Marsh recently called my attention to the wearing of the posterior face of the large upper incisor of *Allodon* by the tip of the lower tooth. This interference forces the jaw backwards as it ascends by a mechanism similar to that in the rodents, as demonstrated by Cope.[3] It has effected a rapid reduction of the other incisors, as witnessed in *Tritylodon* and *Bolodon;* a total reduction, as witnessed in *Polymastodon* and *Plagiaulax*. In contrast with these genera, the recent Diprotodonts present, for the most part, three upper incisors; while the reduction of all, except the median incisors and the fore-and-aft grinding motion, is confined to a single family, the Phascolomyidæ.

(3.) The longitudinal arrangement of the conical tubercles in two or more rows is peculiar to the Multituberculates, and, according to Cope, forms a sufficiently clear sub-ordinal distinction.[4]

The technical question of taxonomic position is, however, of minor

[1] In the Postscript, p. xv., by a slight oversight, the author refers to *Spalacotherium*, instead of *Stylodon*, as having been compared by Osborn with *Chrysochloris*. (See Osborn, Proc. Phila. Acad. 1887.)

[2] Mr. Lydekker mentions (p. 195, footnote) that Lemoine describes two incisors and a canine in the maxillary series of *Plagiaulax*. I have not come across this description.

[3] The Mechanical Causes of the Origin of the Dentition of the Rodentia. American Naturalist, January, 1888, p. 12.

[4] The Tertiary Marsupialia. American Naturalist, 1884, p. 188.

interest. The chief point is the question of phylogeny. In my opinion, the Multituberculata will finally prove entirely distinct from the Diprotodonts and representative of a phylum of genera which reached too great a degree of specialization at the close of the Cretaceous to survive until the recent period. *Thylacoleo* was placed as the latest representative of the Plagiaulax line by Owen, and, later, by Cope; but this view is not shared by Lydekker, who places it near the Phalangistidæ. (Op. cit., p. 188.)

The family arrangement is the same as that proposed by Cope and adopted by myself,[1] with the addition of the Bolodontidæ. We are surprised to find *Microlestes* placed in the latter family instead of in the Plagiaulacidæ; for the type-molars bear only a superficial resemblance to those of *Bolodon*, and closely approach those of *Plagiaulax*.

The Polyprotodont genera are provisionally placed by Lydekker in five distinct families, under the Marsupialia Polyprotodontia. In the arrangement of these genera the author has been at a great disadvantage in not having been able to study the types of the Yale College collection, in which the molars are exposed upon both the inner and outer surfaces, and thus fails to recognize the distinctive features of the molars in many instances. But this will not explain his separation of *Amphilestes* and *Phascototherium* from the Triconodon line and their union with such diverse forms as *Amphitherium*, *Achyrodon* and *Peramus*.

(1.) In the Amphitheriidæ (which embraces, among others, the five genera just mentioned) we are surprised to find (p. 274) that *Peraspalax* is made a synonym of *Amblotherium*. This is explained in a footnote (p. 274), in which a small inner cusp is described upon the lower molars of *A. soricinum*—an interesting observation if correct, because it is entirely opposed to the observations of Owen (Mesozoic Mammalia, 1871) and the writer (1886). According to the latter, *Peraspalax* has prominent internal cusps, separate from the internal —a type of molar found only in the type maxilla of *Peralestes*. The lower jaw of *Peralestes*, type of *Phascolestes* (Owen), is also united with *Amblotherium*. This is more probable, as the outer face of neither genus is certainly known, and the inner faces are very similar; but if *Amblotherium* and *Phascolestes* are alike, both must be removed with *Achyrodon* to the Stylodontidæ.

This turns upon the observations of Owen of impressions of styloid external cusps of the *Phascolestes* molars, which is not confirmed by Lydekker (p. 276), although in *Dryolestes vorax*,[2] Marsh, we have a jaw and dentition closely similar to that of this genus, with styloid external molar cusps. *Amblotherium* and *Achyrodon* have a much more delicate dentition than *Phascolestes;* but the writer anticipates

[1] On the Structure and Classification of the Mesozoic Mammalia. Abstract, Proc. Phila. Acad., June, 1887.

[2] Am. Jour. Sc. and Arts, April, 1887.

that when the outer faces of the lower molars are known they will also prove to be of the *Stylodon* type.[1] The Amphitheriidæ is thus made a miscellaneous family, to embrace genera with lower molars —"multicuspidate, tricuspidate, or differentiated into a blade and talon." "The difference in the character of the lower molars is not greater than obtaining in the Dasyuridæ" (p. 269).

While this may be true, it does not afford sufficient ground for separating *Phascolotherium* and *Amphilestes* from genera with three-lobed molars (*Triconodon*) and placing them with genera with two-lobed molars (*Amphitherium* and *Peramus*). The American genus *Dromatherium*, with unpaired fangs, is also placed in this family, adding to its heterogeneous character.

(2.) Triconodontidæ, *Triconodon*, probably by a typographical error, is stated to have no internal cingulum upon its molars (p. 257). The cingulum is one of the most characteristic features of the molars, and establishes the close homology which exists between the *Triconodon*, *Phascolotherium*, *Amphilestes* and *Spalacotherium* molars, indicating their phylogenetic relation with many mandibular and dental characters in common, that they formed a series of primitive Carnivora. Lydekker follows Marsh[6] and Osborn[5] in making *Spalacotherium* the type of a distinct family, the (3) *Spalacotheriidæ*. The inward rotation of the lateral cusps characteristic of this genus is begun in *Phascolotherium* and extended in *Tinodon*, affording transitions; so that, with the resemblances of the mandible and premolars, it is probable that this genus is an offshoot of the *Triconodon* type. At all events, I cannot now discover family characters sufficient to separate it from the Triconodontidæ. I cannot share the opinion (p. 292) that these molars are of the *Chrysochloris* type; they are rather of a primitive tubercular, sectorial order, leading to the sectorial triangle of the *Didelphys* molar. Upon page 294 we find *Peralestes* (type maxilla, Owen) also placed in this family, and doubtfully separated as a genus from *S. tricuspidens*. The molars of this genus, with separate external and internal cusps, are widely different from those of *Spalacotherium*, the upper molars of which will probably be found to exactly reverse the pattern of the lower. This genus seems, therefore, to be identical with Peraspalax.

(4.) It is in *Stylodon*, type of the Stylodontidæ, that we find the real homologue of the *Chrysochloris* molar[6] and a representative of a true line of Insectivora. Lydekker, although in possession of Marsh's description of the lower molars of the closely allied genus *Dryolestes*, describes the lower molars of the Stylodontidæ as simply conical (p. 290). We have positively no grounds for referring this

[1] In fact, it is probable that several specimens which were referred to *Amblotherium* by Owen really belong to *Stylodon—e.g.*, *A. mustelula* (Plate II., Fig. 2, Owen's Memoirs). The mandibular and premolar structure of this genus and *Achyrodon* is very similar to some of the *Trylodontidæ*. See *Achynodon Names*, Owen, Plate II., Fig. 7.

family to the Marsupialia. No Marsupial presents an analogous dentition. *Perameles*, it is true, bears a similar relation to *Tupaia;* but some stress may be laid upon the fact that the *Stylodon* and *Chrysochloris* are the only known examples of this type of molar.

As Mr. Lydekker himself indicates by his frequent use of the word *provisional*, we are certainly not in a position to reach final conclusions in regard to the classification of the greater number of these Mesozoic genera; and this review of the related portion of this valuable catalogue is intended, in large part, to suggest further inquiry, rather than as an expression of final opinion on my own part. —*Henry F. Osborn.*

Seebohm on the Charadriidæ.[1]—This is another of the handsomely illustrated works of large folio with which the ornithologists of Britain from time to time delight the scientific world, and all other lovers of nature as well. While the present publication does not pretend to be a complete descriptive monograph, diagnostic characters and figures of species and sub-species are given, which are quite sufficient for the determination of the known members, at least, of the family. The scope of the work is indicated by the fact that it embraces as Charadriidæ the tribe Limicalæ of many authors. Especial attention is given, as the title indicates, to the geographical distribution of the members of the family, with especial reference to their evolution.

The first chapter is occupied with the classification of birds in general. The second is devoted to evolution in general. The author here distinctly affirms the doctrine that Natural Selection never originated anything, and he ranges himself on the side of the Neolamarckian school, although he does not say so in precise terms. In this matter he shows himself to be much more perspicacious than those of his countrymen who, like Mr. Romanes, regard this view of the subject as "transparently fallacious" (Romanes in review of Schurman in *Nature*, Feb., 1888). But we take issue with Mr. Seebohm in his expression of evolution in taxonomy. Like Schlosser, he believes that "natural" groups must represent phylogenetic series, and he believes these series to be expressed by the totality of the animals' characters. Thus characters of the specific grade generally in his system take precedence of those usually regarded as generic and even higher. We have objected to this doctrine on various grounds, especially in our essay on The Origin of Genera.[2] First, because generic characters probably express more in phylogeny than specific; second, because specific characters consist of an aggregate of single characters, and each has had a history independent of the others, so that

[1] The Geographical Distribution of the Charadriidæ, by Henry Seebohm. London: Henry Sothern & Co. 1887. 4to, pp. 524.

[2] Origin of the Fittest. D. Appleton & Co. 1887. Art. II.

the history of single characters, one at a time, is a history of the whole; third, because the interruptions in the geological record will always prevent us from making complete phylogenetic series, and our tangible breaks will be transverse to phylogenetic lines; and it is on these breaks that the system will ever depend. Such a system may be called artificial, but it is the only system with definitions that we can ever have. As a consequence of his views on this subject, Mr. Seebohm combines species with three toes in the same genus as those with four, and species with an expanded bill (Eurynorhynchus) with species without such expansion (Tringa).

Like most American zoologists, Mr. Seebohm finds it necessary to adopt sub-specific names, or the trinomial system, for protean groups. In this way the relations of the forms are well expressed throughout this work.

We wonder when the wealthier men of the United States will begin to devote some of their spare time and means to the production of works like this admirable combination of science and art. —*E. D. C.*

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GENERAL NOTES.

GEOGRAPHY AND TRAVEL.[1]

Asia, Etc.—North Borneo.—The account of explorations in North Borneo, by D. D. Daly, published, with map, in the Proceedings of the Royal Geographical Society (January, 1888), is a valuable addition to current knowledge of the great island, a large portion of which has recently fallen under British rule. The most southerly point of British North Borneo is 3° 52′ N.; the most northerly (the northern point of Banguey Island), 7° 25′ N.; the most westerly, 115° 20′ E.; the most easterly, 119° 16′ E. The area is computed at 31,000 square miles, the seaboard at 700 miles, and the population at 150,000. The principle land-locked

[1] Edited by W. N. Lockington, Philadelphia, Pa.

harbors are Gaya, on the northwest coast; Kudat, on the west side of Marudu Bay, at the northern extremity of Borneo; and Sandakan, on the northeast coast. The town of Sandakan, 1000 miles from Singapore, is the seat of Government. The country is divided into the provinces of Keppel, Alcock, Dent and East Coast. Sandakan is on the north side of the harbor, at the base of some steep cliffs, is remarkably healthy, and has a population of about 3000 Chinese, 600 Malays, 300 Sulus, 500 natives and others, and 30 Europeans. Hardly any trouble has been experienced with the natives. The British North Borneo Company was chartered November 1, 1881. Tobacco is the principal crop yet cultivated, and Chinese contract labor furnishes the means, for the climate is not one in which the white man can perform hard work in the open air. The larger half of the island belongs to the Dutch, who are not taking steps to encourage the opening up of their territory. The remainder consists of British North Borneo, Sarawak, and the small independent sultanate of Brunei.

Mr. Daly (August, 1884) entered the Kinabatangan, the largest navigable river of the territory, in a steam-launch. Malapi, about half a degree up this river, is the depot for the edible birds' nests brought from the Gomanton caves, about twelve miles farther north. The value of the nests collected is $25,000 per annum. The height of one of the vaults of these caves has been estimated at 900 feet, and a steady column of Collocalias has been seen to fly from one of the apertures for forty-five minutes. All the birds' nests caves (there are many others) are in isolated mountains of limestone in a country of secondary formation. The settlements along this river and its tributary, the Lokan, which rises near Mount Kinabalu (13,680 feet), seem to be flourishing, durians, langsat, rambutans, mangoes, limes, oranges, lichee and pulasans being among the fruits cultivated. Penungah, still higher up the main river, is a police station, with Sarawak Dyak constables, and its establishment has brought peace among the Tungara, Romanow, and Tambanuah tribes of the vicinity. Several rivers unite near Penungah, all run in gorges between jungle-covered ranges from 2000 to 6000 feet in height, and in the rainy season the waters have been known to lap the foundations of the police station, seventy feet above the river at its usual level.

The Padas river, also ascended by Mr. Daly, is the chief artery of the eastern Province Dent. Its embouchure is a great delta opposite Labuan. The lower course has prosperous settlements of Besayahs, Dusun, etc., with sago-palm plantations and paddy fields. Higher up live the Muruts, who wear no clothes, and are still, where not yet reached by British influence, addicted to head-hunting. The Murut Chief Zalmiboh put his house at Mr. Daly's disposal. It was fifty feet square, and very clean; but from the rafters dangled fifty human heads and pieces of human bones.

Mr. Daly was himself instrumental in making the Muruts and the Peluans of the interior swear to be at peace with each other, and to follow the law of the British North Borneo Company, beneath whose flag they swore friendship.

THE ZONES OF TIBET. — General S. T. Walker, after the reading of Mr. Carey's account of his travels in Central Asia, before the Royal Geographical Society, stated that Tibet might be broadly divided into three zones, which increase in altitude from south to north; a southern zone, 10,000 to 12,000 feet above the sea, containing L'hasa and all the towns and villages of the settled population; a middle zone, 12,000 to 14,500 feet high, comprising the pasture lands of the nomad Bodpas, or pure Tibetans; and a northern zone, 14,000 to 17,500 feet above the sea, partly occupied at certain seasons by Turkic and Mongolian nomads, but mostly abandoned to wild animals. It was this Chang-Tang or northern plain that Mr. Carey had crossed in various parts during his journey to and from Turkestan.

AFRICA. — LAKE SHIRWA. — According to the Rev. A. Hetherwick, there is now no communication between Lake Shirwa, or Chirwa and the Lujenda River. It is very evident that at one time Lake Shirwa covered the broad flat plain to the west of it, and was united to Lake Chinta, the present head of the Lujenda. Gradually the waters fell, and the sandy ridge of Chezomoni appeared. The present lake is very shallow, and grows smaller yearly. Its area is about 350 square miles.

SETE KAMA. — Sete Kama, on the west coast of Africa, is the name given to the district extending from 2° 28′ to 2° 45′ south latitude. European factories are scattered along the beach for about three miles. All the factories have sub-stations on the Ndago lagoon, the old mouth of which has been silted up for three years. It appears that the land is gaining on the sea, for at Ngoné, a mile from the shore, Mr. Walker found an old ship's anchor. Ndago lagoon is of great extent. The Balombo, who inhabit Sete Kama, have a week of four days, as do also some other tribes on the west coast.

GEOGRAPHICAL NEWS. — King Menelik of Shoa has recently annexed Harar, not many years since a part of the Egyptian possessions. The French traveller Rimbaud has returned to the coast from Shoa *via* Harar, thus avoiding the dangerous route through the Danakff country. The distance between Antotto and Harar is 310 miles.

Manitoba has been reduced in area from 123,200 square miles to 60,250, the remainder having been added to Ontario and to the district of Keewatin. The population of the reduced area has risen in five years from 62,260 to 108,640.

GEOLOGY AND PALÆONTOLOGY.

MIMIC EARTHQUAKE NEAR AKRON, O.—A district of country lying about five miles south of Akron, O., was on the night between Thursday, February 9th, and Friday, February 10th, the scene of a commotion that well simulated an earthquake on a small scale. About nine o'clock in the evening a smart shock disturbed the inhabitants and caused much consternation, which was intensified when between two and three the following morning a severer one, accompanied by a loud noise, as of an explosion, awoke the sleepers by shaking the houses and cracking the walls of some of them. When daylight came several long clefts in the ground were discovered, furnishing evidence of some subterranean disturbance during the night.

Similar phenomena occurred almost in the same spot in 1882 and 1883. At that time a cleft from two hundred to three hundred feet long was formed, which crossed a road, marking its course with a furrow, such as that made by a plough. This crack was not more than an inch or two in width, but was sounded with a stick to the depth of several feet (some say fifteen or twenty). It passed under a house, cracking the cellar-wall. The noise accompanying it was likened by some of those who heard it to a cannon fired in the cellar. The explosion of Friday morning last (February 10) was heard by several persons in Akron, at a distance of about five miles.

The writer visited the spot last summer, at the request of a gentleman who had leased several farms, with the intention of drilling for gas. On making inquiry of one of the oldest residents, he learned that an earlier event of the same kind took place about twenty-five years ago, but could get no details.

The phenomena pointed, not to seismic causes, but to subterranean explosions, presumably of gas. The ground is clay and gravel, moraine matter, probably not less than a hundred feet in depth.

Another account differs somewhat in the details: "After the explosion in 1882, then the fissures, some of them nearly half a mile long, radiated to the top of a rise of ground. Mr. Thornton dug a hole nine (9) feet deep at the point where the fissures crossed or formed a centre, and at that depth found the cleft in the earth as pronounced as it was at the surface."

So far as it is possible to determine it, the cause of the commotion is due to the presence of a certain, perhaps a small, amount of natural gas, which, in ordinary circumstances, escapes unnoticed. But when the ground is frozen (and all these explosions have occurred in the winter) the gas is unable to ooze through the soil and

accumulates below the frozen crust, until its elasticity becomes sufficient to burst it; hence the explosion, the shock, and the cracks in the ground.

At the outburst in 1883 several of these cracks could be seen radiating from a central point in a field and extending to different distances. One of the spectators says these clefts divided the field into half or quarter-acre pieces. Similar results followed the late explosion. I have not seen the place since, but learn that the fissures very soon closed, or were filled up in consequence of a rapid thaw.

"One peculiar feature is that while former disturbances rent greater fissures and were accompanied by much greater damage to property than the recent ones, yet, so far as is known, none of the former explosions was heard or felt in this city."

It would be interesting to inquire if any similar events are on record elsewhere in regions yielding natural gas. Perhaps this note may be the means of calling out such cases if they exist.

It may at first sight appear as if so powerful explosions and shocks must indicate natural gas in considerable quantity. But when we reflect that the pressure in a well of small yield rapidly rises to a high figure when the bore-hole is closed, we see that such an inference is not safe. No other indications of gas are yet known in the immediate neighborhood, as would probably be the case if a large supply were accessible.—*E. W. Claypole.*

Geological News.—Primordial.—It is stated that vestiges of the primordial fauna, hitherto unknown in France, have been discovered by M. Bergeron in the Black mountain (la Montagne Noire) of Herault. Conocoryphe and Paradoxides are represented by fine examples.

Devonian.—Mr. A. S. Woodward (*P. Z. S.*, 1887) notes the presence of a canal-system, evidently sensory, in the shields of Pteraspidians. He believes these to represent a "lateral-line" system.

B. Stürtz (*Palæontographica*, Band 32) describes several new echinoderms from the middle strata of the Lower Devonian upon the Rhine. *Ophiurella primigenia*, *Furcaster palæozoicus*, *Bundenbachia beneckei*, and *B. grandis* are the new Ophiuroids and related forms described; the star-fishes include an Astropecten, Palastropecten and Eoluidia, a Loriolaster and a Palasteriscus.

K. A. Penecke has contributed to the Zeitschrift der Deutschen Geologischen Gesellschaft for 1887 an account of the fauna and the age of some palæozoic coral reefs in the eastern Alps.

Dr. J. Walker discusses the structure of Crinoids, with special reference to the species found in the Solenhofer slates and the

Diceras-chalk of Kelheimer, in the 32d volume of *Palæontographica*. Four plates illustrate the memoir.

CARBONIFEROUS.—Mr. Kliver describes (*Palæontographica*, Band. 32) various arthropod remains discovered in carboniferous strata of Saarbrucken and Wettin-Löbejüner. The species include an Ectoblattina, two species of Termes, a Dictyoneura, and an Acridites.

Prof. Boyd Dawkins states his conviction that the soundings for the proposed tunnel across the Straits of Dover will bring to light the existence of vast beds of coal, connected, on the one hand, with the coal measures of Belgium and the north of France, and, on the other, with those of Wales and Somersetshire (England).

PERMIAN.—The second part of Dr. Anton Fritsch's "Fauna der Gaskohle and der Kalksteine der Perm-formation" of Bohemia, has been published. These strata rest upon Silurian rocks. The coals, clays, and ironstones have a carboniferous facies, and the conformable limestones are believed to be true Permian. "The palæontological evidence," says the reviewer in *Nature*, "is somewhat anomalous in the views of purely British fossilists, but it speaks very forcibly and in a most suggestive manner to the students of the Gondwana formation of Hindustan." Two new species of Dendrerpeton are described, and a family Dendrerpetonidæ is characterized.

M. Bayle has found two entire specimens of Gaudry's *Actinodon frossardi* in the Permian deposits at Telots. Gaudry's descriptions were based upon fragments discovered near Antun. Actinodon was probably a carnivorous reptile about $2\frac{1}{2}$ feet long, living more upon land than in the water, and formed for gliding serpentine movements. The stage of evolution presented by this reptile is comparable, according to M. Gaudry, to that of the Chelydosaurus of Bohemia, the Zygosaurus of Saxony and Russia, the Platyops of Russia, the Gondwanosaurus of Hindustan, and the Trimerorhachis and Eryops of Texas. Its scales were disposed in chevrons, its vertebræ were formed of separated pieces, and its large ribs gave attachment to ample muscles.

The internal shell of the Sepiadæ, and its relations with the Belemnites, forms the subject of an article by Dr. E. Riefstahl in Volume 32 of the *Palæontographica*.

The fossil flora of the Red Sandstone and Muschelkalk of the

neighborhood of Commern is described by Dr. Max Blackenhorn in the 32d volume of Zittel's *Palæontographica.*

TRIAS AND JURASSIC. — The German *Palæontographica* (Stuttgart, 1886) contains a geological and palæontological monograph of the "Vilser" Alps, with especial reference to the Brachiopoda. The work is illustrated with fifteen plates and a map of the region. The strata belong to the Trias and Jura. The general facies of the fauna, especially that of the Brachiopoda, is Mediterranean rather than Central European. Several new species are described.

The Asterids of the White Jura of Swabia and Franconia, with researches into the structure of the Echinodermata and the calcareous skeleton of the Asteriadæ, form the subject of the last memoir in Volume 32 of *Palæontographica.*

A new Iguanodon, *I. dawsonii*, has been described by Mr. R. Lydekker from the Wealden strata of the Isle of Wight.

G. C. Laube and G. Bruder describe the Ammonites of the Bohemian chalk in Band. 38 of *Palæontographica.* Eleven Cenomanian, twenty-five Turonian, and fifty-seven Senonian forms are enumerated, several of them new. The memoir is illustrated by six plates.

Mr. A. S. Woodward (*P. Z. S.*, 1887) refers the genus Rhacolepis, Agassiz, to the neighborhood of the Clupeidæ, and places it near Elops. It seems to have been one of the forerunners of the latter to have been developed in Jurassic times, and to have swarmed in Cretaceous seas. The fossils are common in the Serra de Araripe, in Northern Brazil.

CRETACEOUS.—Herr Carl Diener, in a contribution to the knowledge of the Cretaceous formation of Syria (Zeit. d. Deutschen geol., ges. 1887) gives a table of subdivisions, placing the Lebanon chalk partly in the Turonian and partly in the Cenomanian and the Arâja-Kalkstein at the bottom of the series.

M. S. Meunier, from experiments made upon the chalk of Beauval with acidulated water, arrives at the conclusion that the deposits of phosphate of lime found in chalk originated in the same way as the concretions of flint in the same material, *i.e.*, the two substances are sensibly soluble under like conditions, and their method of concretion is similar. It is a concentration by capillary action of a material which was originally distributed uniformly.

TERTIARY.—Mr. A. S. Woodward revises the British Eocene

species of Myliobatis in the January issue of the *Ann. and Mag. Nat. History.* He distinguishes four—*M. dixoni*, *M. striatus*, *M. toliapicus*, and *M. labidens*, new species, the last from the Brackleshem Beds.

Mr. A. S. Woodward (*P. Z. S.*, 1887) asserts that a fossil representative of Chlamydoselachus, Garman, from the Pliocene beds of Oreiano in Tuscany, was described and figured (under another name) by Mr. R. Lawley in 1876. He suggests that this species be named *C. lawleyi*. The figures will be found in "Nuovi Studi sopra di Peci ed albri Vertebrati fossili delle cobline Toscane," di Roberto Lawley, Florence, 1876.

Dr. O. Roger describes (*Palæontographica*, vol. 32) some teeth of *Dinotherium bavaricum* H. v. Meyer, discovered in the valley of the Zusam, a small tributary to the Danube.

M. Lemoine has discovered in the eocene beds near Rheims, the teeth, jaws, etc., of five generic types of carnivora. The first of these equals Arctocyon in size, and seems analogous to Dissacus Cope. The two molars preceding the last show a commencement of the division of the anterior cusp of the tooth. Another type approaches Proviverra; another is named Tricuspiodon from the three cusps which in the molar teeth precede a very small heel, and recalls the Spalacotherium of the Prexbeek beds while another (Procynictis) has very singular molars, yet presents analogies with Amblotherium and Peramus of Owen. These forms tend to link the mesozoic with more recent faunas.

M. Gaudry has recently announced to the Acad. de Sciences of Paris the discovery of a gigantic tortoise in the middle Pliocene of Perpignan. The head, limbs, and part of the neck have been recovered from the encasing hard rock. In size this tortoise exceeds any living species, since the carapace is 1.20 metre long and a metre wide. The carapace of the Aldabra tortoise (*Testudo elephantina*) scarcely reaches a length of one metre. The only other tertiary or later fossil tortoises equalling in size the *Testudo perpiniana*, and that discovered twenty years since by M. Gaudry in the miocene of Mt. Lebanon, and a sub-fossil species (*T. grandidieri*) brought from Madagascar by M. Grandidier. *T. perpiniana* seems to have more affinity to *Testudo irrepta* and *triseriata* of Mauritius than to any others, since like them it has a depressed smooth carapace, relatively slender limbs, etc. In the great development of its sternum, however, it approaches the Atdabra tortoise.

Mr. A. Bell (*Geol. Mag.*, Jan., 1888) enumerates the few species of British Upper Tertiary corals known, and gives a description of *Sphenotrochus boytonensis* Tomes, n. sp.

The first part of Band. 32 of Zittel's *Palæontographica* contains "Contributions to the Knowledge of the Bryozoan-fauna of the Older Tertiary of Southern Bavaria," by Carl Koschinsky.

The Tertiary plants from the valley of the River Buchtama, at the foot of the Atlas, and described in *Palæontographica* (1886–87) by J. Schmalhausen.

PLISTOCENE. — Carl Ochsenius has contributed two papers upon the age of some parts of the South American Andes to the Zeitschrift der Deut. Geol. Ges. (1877). He attributes the elevation of the platform of Lake Titicaca to volcanic action, and assigns it to quaternary time.

MINERALOGY AND PETROGRAPHY.[1]

PETROGRAPHICAL NEWS.—In an article on the contact phenomena presented by certain Scottish olivine diabases, cutting sandstones and shales, Stecher[2] gives us some new and important ideas on the general subject of contact action. These olivine diabases are carefully described in all their varieties. Skeleton crystals of apatite, corroded augites, twinned plagioclase, dihexahedra of quartz, and various rare minerals are noted in them. The quartz shows anomalous action in polarized light, and is peculiar in that its hexagonal sections are seen under crossed nicols to consist of a kernel of quartz substance, surrounded by a rim of calcite. In some instances the olivine yields analcite by alteration. The most interesting portion of the paper is that which treats of the endogenous changes which have taken place in the dykes under the influence of the intruded rocks. Although more acid on their edges and in the neighborhood of sandstone inclusions, it was found that only in these places in the dykes is there any considerable development of olivine in perfect crystals. At a somewhat greater distance from the contact, the olivine becomes more skeleton-like in form. In the centre of the dykes it is absent. This is accounted for by Stecher in supposing that the material of the dykes cooled quickly on its edges, and thus preserved in their entirety the olivine which had already crystallized before the rock reached the surface of the earth. As the inner portion cooled more gradually, the magma became more acid as it dissolved material from the sandstone and slate pieces, torn from its walls, and thus re-dissolved the olivine, and then solidified under the changed conditions.—In contrast to the results obtained by Stecher, in which the effect of contact action is seen only in the eruptive rock, are those obtained by Greimi[3] in his studies of the phenomena presented by the intrusion of the Upper-Devon-

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Maine.
[2] Min. u. Petrog. Mitth. ix., 1887, p. 145.
[3] Neues Jahrb. f. Min., etc., 1881, i., p. 1.

ian schists by diabase, in the neighborhood of Weilburg an the Lahn, in Hessen, Nassau. In this case the diabase itself has suffered little alteration, but the schists show to a greater or less degree the effects of metamorphic action. The unaltered schists are composed of quartz, muscovite, hematite and other iron oxides, in which are lenticular areas and beds of calcite. Where altered they are seen to contain an isotropic groundmass in which are quartz, mica and a chloritic mineral. In addition to these the two newly formed minerals spinel and andalusite occur. In discussing his results, Greim concludes that the diabase supplied sodium and iron to the schists, which then underwent the alteration which is supposed by Rosenbusch to be characteristic of deep-seated metamorphism. —A third excellent paper on contact phenomena is that communicated by Rüdemann. This author has investigated the effect of the granite occurring at Reuth, near Gefrees, in the Fichtelgebirge, upon the clay slates, phyllites and amphibolites through which it cuts. He carefully describes the knotty-schists (Knoten-schiefer), the chiastolite and andalusite schists, and the hornfels resulting from this action, and reaches some general conclusions relative to the way in which an eruptive rock acts in the production of what are commonly known as contact rocks. In both phyllites and clay slates the first result of the metamorphic action is the concentration of certain of their constituents to form the spots (Knoten). In this stage there is little or no other change to be detected. The next stage is characterized by the formation of porphyritic crystals, chiastolite in the clay slates of Reuth and other localities, and biotite in the case of phyllites (Garbenschiefer). In the first case the andalusite owes its origin to the alteration of a light green chloritic mineral (grümbelite). In the case of the phyllites biotite replaces chlorite. In the third stage the end product of the alteration both of clay slates and phyllites is hornfels. This is a crystalline rock composed of quartz, biotite, muscovite and andalusite grains. Assuming that these changes in the sedimentary beds are directly connected with the presence of the large granite mass which they surround, the author supposes the earlier stages in the alteration to be due to the intense heating to which the rocks were subjected at the time of their intrusion by the granite. This is shown by the fact that in different beds different contact minerals have been produced, while the composition of the altered rocks corresponds to that of the corresponding unaltered beds from which they were derived. To account for the formation of hornfels, and the minerals so commonly found in it, Rüdemann supposes the energetic action of hot waters upon the constituents of the fragmental rocks. The paper is exceedingly well written, and contains very much of interest.—In connection with the discussion of

[1] Neues Jahrb. f. Min. etc., B. B. v., p. 643.

contact phenomena, a late paper by Hussak,[1] on the origin of the spots in altered sedimentary rocks (Knoten-and Frucht-schiefer) is worthy of close study. Rosenbusch regards these spots as due to the aggregation of the pigment, which was distributed evenly throughout the fragmental rocks before their intrusion by the eruptives. In certain cases he supposes these aggregations to pass by recrystallization into chiastolite and andalusite. Ward regards them as undeveloped andalusites. Other writers have described them as possessing characteristics which indicate their close connection with other mineral species. Hussak, upon examining the spotted schists from Tirpersdorf, Saxony and Hlinsko, Bohemia, found that the darker portions of the altered schists possess properties which can only be explained by supposing them to be the remains of altered cordierite, in the case of the Saxon rocks, and of altered chiastolites and andalusites in the rocks from Bohemia.

MINERALOGICAL NEWS.—Busz[2] has recently made quite an extensive study of *sphene* in order to determine whether the optical properties of different crystals are in any way dependent upon their chemical composition. Although quite a number of analyses of well crystallized specimens from various localities were made, no direct relation could be traced between their compositions and optical properties. The most instructive portion of the paper is that which treats of the crystallography of the subject. Crystals of nine different types are pictured on three lithographic plates. A number of new forms were detected, which added to those already known make a total of seventy-five thus far identified on the species.—Köchlin[3] has examined several of the oxides of manganese to decide as to the correctness of certain views held in regard to them. He finds as the result of etching that *manganite* is holohedral as Groth supposed. He believes *polianite* to exist as an independent mineral species distinct from manganite. It is orthorhombic, with an axial ratio: 1 : 10513; 1 : 0.63177. Finally, he regards *pyrolusite* as a mixture without a definite composition. "Its substance is not individualized; it has no proper crystal form." It occurs almost exclusively as a decomposition product of other manganese minerals.—Although *pseudobrookite* was first described by Koch[4] some ten years ago, our knowledge of its optical properties is very limited. A new discovery of little crystals of the mineral in a nephelinite from Katzenbuckel has given Lattermann[5] the opportunity to determine its optical constants. The tiny crystals are bounded by the planes $\infty P\bar{\infty}$, $\infty P\breve{\infty}$, ∞P and $\frac{1}{3} P\bar{\infty}$. Their color is orange brown. They are weakly pleochroic. The plane

[1] Min. u. Petrog. Notizen, Bonn.
[2] Neues Jahrb. f. Min., etc. Beil. Bd. v., p. 330.
[3] Min. u. Petrog. Mitth. ix., 1887, p. 22.
[4] Min. u. Petrog. Mitth. ,1878, i., p. 344.
[5] Min. u. Petrog. Mitth. ix., 1887, p. 47.

of their optical axes is the basal pinacoid, and the axial angle, measured in oil, is 85° 30′. *A* is the acute bisectrix. The mineral is insoluble in hydrochloric acid. It dissolves slowly in boiling sulphuric acid, but rapidly in a mixture of sulphuric and hydrochloric acids. An analyses of separated material yielded: Tio_2 = 46.79%; Fe_2O_3 = 48.64% Mgo = 4.53%. Very beautiful rich red, transparent crystals of *rhodochrosite* are described by G. F. Kunz[1] from the John Reed mine in Alicante, Lake co., Colorado. Some of the crystals from this locality "are as pellucid as red Iceland span and show the same double refraction." The same author[2] describes some curious groups of quartz crystals from the vicinity of the town of Pinal, Pinal CO., Arizona. Six or more little crystals of the usual form are so arranged as to form a hollow cylinder, with the general outline of a large quartz crystal. He also mentions a white opaque variety of hydrophane from Colorado, which is remarkable in that it can absorb more than its own volume of water. When wet it is perfectly transparent.—Mr. R. B. Riggs[3] of the United States Geological Survey has published the results of the analyses of a suite of tourmaline crystals from various localities. The conclusions reached by Mr. Riggs, after an immense amount of very careful work, are of very great interest as establishing with a good deal of accuracy the composition of this complicated group of minerals. The figures obtained lead the author to regard tourmaline as a simple boro-silicate with the general formula $R_9\ Bo_2\ (S\ i\ O_4)_2$, which for the three types recognized by him became:

I. Lithia tourmaline = 12 SiO_2. $3B_2O_3$. $4H_2O$. $8Ae_2O_3$. 2 $(NaLi)_2O$.

II. Iron tourmaline = 12 SiO_2. $3\ B_2O_3$. $4H_2o$. $7AE_2O_3$. 4 Fe.O. Na_2O.

III. Magnesia tourmaline = 12 SiO_2. $3B_2O_3$. $4H_2O$. $5AE_2O_3$. $2\frac{8}{3}$ MgO. $\frac{2}{3}$ Na_2O.

It is interesting to note that while the color of the iron and magnesian varieties depends upon the *amount* of iron in their compositions, in the case of the lithium varities, containing manganese and iron, it depends upon the *ratio* between the manganese and iron constituent, being colorless, pink or pale green when the amounts of these are equal, red when manganese is in excess, and green or blue when iron is in larger quantity.

[1] Amer. Jour. Sci., Dec. 1887, p. 477.
[2] Ib., p. 479.
[3] Ib., Jan., 1888, p. 35.

BOTANY.[1]

PLANCHON'S REVISION OF THE AMPELIDEÆ.—In the recently received Part 2 of the fifth volume of De Candolle's Monographiæ Phanerogamarum, J. E. Planchon makes a thorough revision of the Ampelideæ. Such considerable changes are introduced in the synonymy that it may be well to present a summary of the work here.

The order is restricted somewhat from the limits assigned it by Bentham and Hooker in the *Genera Plantarum*, by the exclusion of Leea with its twenty species or so. The remaining species (386) are distributed among ten genera, instead of two, as in the *Genera Plantarum*. It will be remembered that in the latter work the authors reduced almost everything to one genus—Vitis. Planchon, on the contrary, divides the old genera and constructs several new ones. The following abridged conspectus of the genera will serve to show their principal characters, and the method pursued in differentiating them:—

Flowers polygamo-diœcious; petals 5, cohering; style (short) conical; hypogynous glands 5; berries two-celled, 2–4 seeded; climbing shrubs with simple, variously lobed leaves.....I. *Vitis.*

Flowers polygamo-monœcious; petals 5 (rarely 4), spreading; style short-conical; disk annuliform, erect; berries two-celled, 2–4 seeded; climbing shrubs with simple or palmate or palmately compound leaves.....II. *Ampelocissus.*

Flowers polygamo-monœcious; petals 4–5, spreading; style short; disk annuliform; berries two-celled, 2–4 seeded; shrubs with undivided or palmatisect leaves.....III. *Pterisanthes.*

Flowers polygamo-monœcious; petals 5, free, spreading; style long, subulate; disk cup-like; berries two-celled, 2–4 seeded; shrubs, with 5–3 foliate leaves.....IV. *Clematicissus.*

Flowers polygamo-diœcious; petals 4, expanding; style short; stigma 4 lobed; disk hypogynous; berries 2–4 seeded; shrubs with pedate leaves.....V. *Tetrastigma.*

Flowers polygamo-monœcious; petals 5, expanding; style short; disk 5 lobed, adnate to ovary; berries 2 celled, 3–4 seeded; shrubs with 3-foliate leaves.....VI. *Landukia.*

Flowers hermaphrodite; petals 5, spreading; style subulate, thick; disk obsolete; berries 1–2 seeded; climbing shrubs with digitate or palmatilobed leaves.....VII. *Parthenocissus.*

Flowers hermaphrodite; petals 5 (rarely 4), spreading; style subulate; disk cup-like, 5 (rarely 4) lobed; berries 1–2 celled, 1–4 seeded; climbing shrubs with leaves from simple to pinnately compound.....VIII. *Ampelopsis.*

[1] Edited by Prof. Chas. E. Bessey, Lincoln, Neb.

Flowers hermaphrodite or pseudo-hermaphrodite; petals 5–7, thick, spreading; disk annular; berries 1–2–3–4 seeded; climbing shrubs with trifoliate, unifoliate, undivided or palmatilobed leaves. .....IX. *Rhoicissus.*

Flowers hermaphrodite; petals 4, spreading or sometimes cohering; style subulate, slender; disk cup-like; berries 1–2–3–4 seeded; creeping, erect or climbing shrubs with undivided, lobed or compound leaves.....X. *Cissus.*

The species of Vitis are arranged in two sections, viz., I. Euvitis and II. Muscadinia, the former containing seven series. The disposition of our North American species under this arrangement is as follows —

Section I. Euvitis.

Series 1. Labruscæ.

V. labrusca L. Fox Grape. Atlantic States.

Series 2. Labruscoideæ.

V. candicans Engelm. Mustang Grape. Texas.

V. caribæa D. C. South Florida.

Series 3. Æstivales.

V. æstivalis Michx. Summer Grape. Atlantic States and Mississippi Valley.

V. lincecumii Buckl. (= *V. æstivalis* Michx., var. lincecumii Engelm). Post Oak Grape. Texas.

Series 4. Leucobryæ.

V. californica Benth. California.

V. arizonica Engelm. Arizona.

Series 5. Cinerascentes.

V. berlandieri Planch. (= *V. monticola* Durand in Bull. Soc. d'Acclim., ix., p. 434,— *V. monticola* Engelm. in Bush. Cat.— *V. æstivalis* A. Gray in Plantæ Lindheimerianæ). Texas and New Mexico.

V. cinerea Engelm. (= *Vitis æstivalis* Michx. var.? *cinerea* Engelm. in Gray's Manual, p. 679). Mississippi Valley from Illinois southward.

V. coriacea Shuttl. (= *V. caribæa*? in Chapman's Flora of the Southern States.— *V. candicans* in Watson's Bibliographical Index to N. A. Botany). South Florida to Louisiana.

Series 6. Rupestres.

V. rupestris Scheele. Sugar Grape. Tennessee, Missouri and southwestward.

Series 7. Cordifolio-Ripariæ.

V. cordifolia Michx. Frost Grape. New York to Nebraska, and southward to the Gulf of Mexico.

V. riparia Michx. Riverside Grape. Labrador to Florida, and West to the Rocky Mountains. This species includes the form *palmata* of Engelm.

V. rubra Michx. Tennessee to Missouri and southward. Related to, and generally confused with, the preceding species.

Section II. Muscadinia.

V. rotundifolia Michx. (= *V. vulpina* L. in Gray's Manual, p. 113). Muscadine Grape. Maryland and Kentucky to Arkansas and southward.

Two other species are described, but for want of full material their places in the adopted scheme are not assigned. They are:—

V. araneosa Leconte, from northern Georgia and Illinois.

V. monticola Buckley, from Texas. This is regarded by Watson (Bibl. Index N. A. Bot., p. 171) as a variety of *V. æstivalis* Michx.

The genus Parthenocissus includes seven species, one of which is *P. quinquefolia* Planch., the well-known "Virginia Creeper," of the United States, hitherto known as *Ampelopsis quinquefolia* Michx. In this genus is found, also, the Japan Creeper (*Ampelopsis veitchii* of the gardeners), hereafter to bear the name of *P. tricuspidata* Planch.

Ampelopsis, as now restricted, contains two North American species, viz., *A. cordata* Michx. (= *Vitis indivisa* Willd. of Gray's Manual, p. 113), and *A. bipinnata* Michx. (= *Vitis bipinnata* Torr. and Gr. of Gray's Manual l. c. and *V. arborea* L. of Watson's Bibl. Index N. A. Bot., p. 171).

Cissus now includes 214 species, of which but three are found within the United States, viz., *C. sicyoides* L., with many subvarieties or forms, of which *floridana* occurs in southern Florida; *C. acida* L., southern Florida; *C. incisa* Desm., Florida to Texas.—*Charles E. Bessey.*

Postal Regulations as to Botanical Specimens.—In a communication dated Feb. 11th, 1888, to Dr. Charles R. Barnes, of the University of Wisconsin, the Third Assistant Postmaster-General makes the following ruling, viz.:—

"Under the recent Act of Congress in relation to permissible printing and writing upon second, third and fourth class matter, there may be placed upon specimens of dried plants, or on any other

natural history specimens, to be transmitted by mail, without subjecting them to other than fourth-class rate of postage, labels bearing the written name of the specimens, locality and date of collection, and the collector's name—where these inscriptions are wholly for purpose of identification or description."

Ordinary botanical labels which had been submitted by Dr. Barnes were accepted as permissible.

THE GERMINATION OF DODDER.—In some recent investigations on germinating Dodder (*Cuscuta gronovii*) we have observed an interesting fact in regard to the manner of separating itself from the soil which we have not found mentioned elsewhere. When the plant has reached something adapted to its needs as a parasite—*Forsythia viridissima* in our observations—it winds about it loosely at first, then after the manner of a tendril quickly contracts, bringing its coils close to the host, that the haustoria may penetrate the bark. This contraction pulls up the root, leaving it loosely hanging by the host, sometimes half an inch above the soil, where it withers and dries.—*Henrietta E. Haaker, Botanical Lab., Mt. Holyoke Sem., Feb.* 17, 1888.

THE FOSSIL FORESTS OF THE YELLOWSTONE NATIONAL PARK.—At the February meeting of the Washington Biological Society, Professor Knowlton gave an account of a visit to these fossil forests, which are located mostly in the northeastern portion of the park, a locality rarely visited by tourists. The largest isolated trunk seen was twenty-six feet in circumference, without the bark, and twelve feet in height. In the edge of a cliff trunks are exposed to a height of thirty feet. Specimens from about 300 of these trees are now being identified. They represent about twenty species, including the genera Pinus, Sequoia, and Taxus.

NEW SPECIES OF UREDINEÆ.—At the February meeting of the Washington Biological Society a paper was read by B. T. Galloway describing seven new western Uredineæ collected by Tracy and Evans in 1887, and named by Tracy and Galloway. They were *Uromyces arizonica, Puccinia fragilis, Puccinia caulicola, Puccinia vertisepta, Æcidium draba, Æcidium heliotropii*, and *Æcidium ellisii*. It is to be hoped that the authors will also publish their descriptions in the *Journal of Mycology*, in which, in our opinion, all descriptions of our fungi ought to appear.

BOTANICAL NEWS.—The announcement is made that Dr. Lorenzo G. Yates, of Santa Barbara, California, with the assistance of J. G. Baker, of Kew (England), will soon bring out a book entitled "All Known Ferns," which will consist of an alphabetical list

(generic and specific) of all the ferns of the world. It is not to include descriptions, but references are to be given in every instance to descriptions. Synonyms will be given, and the distribution of every species will be indicated. It promises to be a very useful book.——Miss Jane H. Newell, of Cambridge, Mass., has begun the publication, in parts, of a little work to be called "Outlines of Lessons in Botany," designed to be of use to teachers who wish to do more than follow the old methods of botanical teaching. The lessons outlined "are suitable for children of twelve years of age and upwards." Directions are given for raising seedlings, and for making observations upon them in their growth. The parts before us are privately printed, in order to have them tested by other teachers before publication. They may be obtained by any teacher who will use them experimentally, by addressing the author at 175 Brattle street, Cambridge.——DeBary's Lectures upon Bacteria, English translation, has been received from Macmillan & Co. It is a small work, of a sufficiently popular style to enable any well-educated man to get a good idea of the subject. A fuller notice will appear later.——Detmer's Pflanzenphysiologische Praktikum, from Gustav Fischer, of Jena, promises to be a most valuable book in the botanical laboratory. It is an octavo of 352 pages, and is illustrated with 131 wood-cuts.——Dawson's "Geological History of Plants" is an interesting volume of the International Scientific Series, which has just appeared. The style is popular, but the treatment is thoroughly scientific.

ZOOLOGY.

Conjugation of the Infusoria.—The following abstract of M. E. Maupas's observations on the conjugation of the Infusoria (*Comtes Rendus*, 1887, p. 356–9) is taken from the *Journal of the Royal Microscopical Society*. The micronucleus is a hermaphrodite sexual element, of sole importance in conjugation. In the stage (A) it increases in size; it then divides twice (B and C), and eliminates the corpuscles de rebut. This effected, it divides again (D), differentiating a male and female pronucleus. In the next stage (E) the male elements of the two conjugating Protozoa are exchanged, and the new male nucleus fuses with the original female portion. In the next two stages (F and G) the nuclear dualism characteristic of the Ciliata is re-established (the old macronucleus having broken up and been eliminated meanwhile). In the last stage (H) the ex-conjugates reassume their original organization before dividing for the first time.

What is the meaning of all this? There is no special sexual reproduction or generation. There is no acceleration of division after conjugation. It is a period of risk, especially during the

inertia of reconstruction. An *Oxydromus grandis* had from 40,000 to 50,000 descendants while a pair were indulging in a single conjugation. It is a source of destruction, not of the multiplication of individuals.

The riddle was solved by a long series of careful observations. In November, 1885, M. Maupas isolated a *Stylonychia pustulata*, and observed its generations until March, 1886. By that time there had been 215 fissiparous generations. But at that time the colony gave in; the individuals had lost the powers of nutrition and reproduction. Individuals removed at various stages, however, had conjugated with individuals of a different origin. The same experiment was repeated with other forms. In March, 1886, an ex-conjugate from one of the couplings referred to was removed and watched until July 10, when the family again gave in. During that time 315 divisions had been observed. Numerous conjugations had been effected with members removed to other families. This was done till the 130th generation, and till then all the conjugations were fertile. About the 180th generation individuals of the same family which had not hitherto been in contact with one another began in despair to conjugate. The results, however, were *nil;* the conjugates did not even recover from their forlorn hope. Other cases are related.

The result is evident. The process is essential for the *species*. The life runs in developmental cycles of multiplication by division, which are strictly limited. If conjugations with unrelated forms do not then occur the life ebbs. The sexual conjugation of the Ciliates is thus a rejuvinescence, as Bütschle and Engelmann maintained. It is essential as a reorganization of the nucleus. After a prolonged series of divisions the nucleus undergoes senile degeneration. Without conjugation death would be inevitable. The death is a natural one, which some would deny. Sexual conjugation is the necessary condition of their "eternal youth and immortality."

Germinal Layers of Loligo.—Mr. S. Watase has been studying the development of *Loligo pealei*. He finds that, owing to the immense amount of food yolk present, the gastrulation is masked, and that the mesoderm is formed before the endoderm is fully outlined. He traces the origin of the ink-bag and rectum from the proctodeal invagination, while the stomodeal inpushing gives rise to radula sac, salivary glands, and the digestive glands or "liver." The endoderm is concerned only in forming a yolk membrane, and Mr. Watase thinks it wholly disappears, taking no part in the structure of the adult organs, the alimentary tract being formed solely of stomodeal and proctodeal invaginations.

The Sponge Shrimp, Alpheus.—Mr. F. H. Herrick contributes three articles on Alpheus to No. 63 of the John Hopkins

University Circulars. He has studied five of the eight known West Indian forms, and finds that they vary considerably in habits and life history. *Alpheus minus* has a complete metamorphosis; in *A. heterochelis* the metamorphosis is abbreviated, while in a species provisionally called *A. præcox* it is almost lost, the young having the big claws developed when it escapes from the egg. In twenty-four hours after hatching the young of the last-mentioned species molt twice, and then have, except size and color, all the characteristics of the adult, even to the pugnacious habits. Although but a tenth of an inch in length, they snap the fingers quite audibly. Mr. Herrick attributes this abbreviation of the development to the parasitic habits, this species, like some others, living in sponges, but burrowing more deeply in them than do the others.

In the embryonic development Mr. Herrick notes that the segmentation proceeds until a syncitium of eight nuclei is formed, and then arise yolk pyramids. After the nuclei reach the surface a germinal area is outlined, and then nuclei migrate from all parts of the surface into the yolk. The gastrulation, which is small, occurs later, and its products likewise pass into the yolk, most of them wandering to the dorsal surface. These wandering cells are believed by endogenous growth to give rise to the "secondary mesoderm cells." Some of these are regarded as forming the regular mesoderm, while others give rise to the blood corpuscles. A remarkable plasticity of the early germinal layers is noticed, it being almost impossible to separate the products of invagination into layers, or to separate others which wander from the ectoderm to which they apply themselves.

Phosphorescent Organs of Fishes.—On the head and sides of certain deep-sea fishes occur small shining bodies, which Leuckart, Ussow, and Emery have regarded as accessory eyes, but which are now considered as phosphorescent organs. Dr. R. von Lendenfeld has recently studied these organs as exhibited in the collections of the "Challenger" Expedition, and comes to some interesting conclusions. He recognizes no less than twelve types, more than one of which may occur on a single fish. Most of these are small rounded bodies scattered or regularly-arranged upon the upper surface of the body; these are called the "regular ocellar phosphorescent organs," and may be either simple or compound. The simple forms are always isolated, and may be divided into two types according as they are provided with (*Opostomias micripnus, Echiostoma barbatum, Pachystomias microdon, Malacosteus indicus, Astronesthes niger*) or lack a pigmented mantle (*Opostomias micripnus*). In no case are they provided with a reflector. The compound organs, which always have a pigmented mantle, consis of a proximal sack-like body and a distal goblet-shaped half, the two portions being separated by a constriction. Some of these (*Oposto-*

mias micripnus, Echiostoma barbatum, Pachystomias microdon, Astronesthes niger) are isolated and stand upright upon the surface, but are still more distinguished by the lack of a reflector. In others (*Argyropelecus hemigymnus, Sternoptyx diaphana, Scopelus benoiti*) the organ is provided with a shining reflector composed of needle-shaped or filiform elements. All of the foregoing are sunk in the skin, but in *Xenodermichthys nodulosus* occur simple organs which are provided with a pigmented mantle, and which project beyond the general surface and in some cases become stalked. In *Halosaurus macrocheir* and *H. rostratus* the organs are situated upon the scales of the lateral line and have a spindle shape.

The other main group of organs embrace irregular glands which may be scattered (*Astronesthes niger*), or be found on the under jaw (*Argyropelecus hemigymnus, Sternoptyx diaphana*); beneath the operculum (*Halosaurus macrocheir*); on the barbels and fin-rays (*Opostomias micripnus, Malacosteus indicus*); or may have a suborbital position, in the latter instance either having (*Echiostoma barbatum, Pachystomias microdon, Malacosteus indicus, Scopelus benoiti*) or lacking a reflector (*Opostomias micripnus, Astronesthes niger*).

The histology of these various types is described. All of the ocellar organs have a large blood and nerve supply, as do the suborbital organs of the other division. The others are tubular glands. Usually the ocellar organs are innervated from branches of the spinal nerves, but in *Echiostoma barbatum* the suborbital organs receive their nerve supply from a branch of the trigeminus, which suggests a comparison with the electric nerve of the torpedo.

Both Guppy and Willemoes Suhm have witnessed the phosphorescence in Scopelus, and the similarity in structure of all these organs renders it probable that all are phosphorescent. Regarding the glandular organs the evidence is less direct, but judging from the analogy of other forms von Lendenfeld regards them as secreting a phosphorescent mucus. In both we have to deal with various modifications of the mucous canal system. Dr. von Lendenfeld states that the parietal organ of Sphenodon (Hatteria) has no homology with these organs, and that it is not, as has been suggested, a phosphorescent organ.

Eutheria and Prototheria.—In the American Naturalist for December, 1887 (vol. xxi., p. 1103), in a notice of "Thomas on Mammalian Dentition," it is "observed that the unnecessary terms Prototheria and Eutheria, which are generally ascribed to Professor Huxley in England, were really introduced by Professor Gill."

Two quite different propositions were involved by the use of the terms used by Professor Huxley and myself. Professor Huxley

simply substituted my names Prototheria for the Ornithodelphia or Monotremes, and Eutheria for the Monodelphia or Placentalia, introducing a new term—Metatheria—for the Didelphia or Marsupialia. I perfectly concur with the belief that in these senses the terms are unnecessary. But far different was my use of the terms in question, and they were the expressions of a higher generalization. Almost universally the placental mammals had been contrasted with the non-placental. In my "Arrangement of the Families of Mammals" (1872), however, I combined (pp. 45, 46) the Placentals and Marsupials in one category (I.) with the Monotremes, in another (II.) fortifying the contrast by numerous anatomical characters; for these two sections I proposed the names EUTHERIA (I.) and PROTOTHERIA (II.) in the table of "Contents" (pp. v., vi.) of the Arrangement. Subsequently, in "Johnson's New Universal Cyclopædia" (vol. iii., 1877, p. 262), in the long article "Mammals," I adopted the terms in connection with the definitions. It was then previsedthat "the chief modifications of the class of Mammals are expressed in three types which have been differentiated as sub-classes, viz., Monodelphia, Didelphia, and Ornithodelphia; these are themselves opposable under two categories, EUTHERIA and PROTOTHERIA." Immediately following, the groups so named were defined at length.

In the sense in which the terms Eutheria and Prototheria were used by myself I consider them to be necessary as the verbal expressions of the generalizations formulated, but as used by Professor Huxley the names are simple synonyms of others long before in general use, and consequently "unnecessary."—*Theodore Gill.*

THE MULTITUBERCULATA MONOTREMES.—It is announced in *Nature* (Feb. 16, 1888, p. 383) that Mr. E. B. Poulton has discovered teeth in sections of the jaws of a young *Ornithorhynchus anatinus*, made by Professor W. N. Parker. Three have been found in the upper jaw and two in the lower (the ramus imperfect), in the regions covered by the corneous bodies of the adult. The anterior tooth of the maxilla is "long, narrow and simple, as compared with the others." The other teeth "were broad and large, those of the upper jaw containing two chief cusps in the inner side of the crown, and three or four small cusps on the outer side, while this arrangement was reversed in the lower jaw."

This observation is of the highest importance. The description reads like that of the dentition of the Plagiaulacid genus Ptilodus. *It renders it extremely probable that the Multituberculata are Monotremata*, and not Marsupialia, as has been supposed.—*E. D. Cope.*

ZOOLOGICAL NOTES.—PROTOZOA.—Dr. D. S. Kellicott describes and figures five new species of American Infusoria in the *Microscope* (vii. p. 226). They are *Podophrya inclinata, P. flexilis, Carchesium granulatum*, and *Opercularia humilis.*

Professor Ernst Haeckel has published an abridgement of his recent monograph of the "Challenger" Radiolaria. It appears under the title "Grundriss einer allgemeine Naturgeschichte der Radiolarian," in a quarto volume of 266 pages, illustrated with 64 of the plates of the "Challenger" Report. The price is sixty marks.

ECHINODERMS.—The brothers Sarasin call attention (*Zool. Anz.*, x. 674) to the powers possessed by *Linckia multifora* of repairing injuries, and figure a specimen where an arm has budded at its extremity a new star fish with four new rays, but state that the madreporic body is not yet developed.

WORMS.—Beddard calls attention (*Zool. Anz.*, No. 268) to the so-called prostrate glands of earth-worms, claiming that these organs in Perichæta an the homologue of the atrium in other earth-worms. He also describes the reproductive organs of Monilogaster, which differ from those of other worms and resemble those of the limicolous forms. He shows that Claparède's division of the Oligochætes is unnatural.

MAMMALS.—August Fjelstrup describes (*Zool. Anz.*, No. 269) the histology of the skin of the black fish, *Globiocephalus melas*, and incidentally states that Eschricht's statement that the number of hairs about the lower jaw and nasal openings and their arrangement may be used in identifying fœtal Cetacea is erroneous, these varying with size and development.

ENTOMOLOGY.[1]

THE GRASS-EATING THRIPS.—Attention is called by Dr. Lintner in his annual report (reviewed below) to "An Unknown Grass-Pest." As the insect in question is one which I have had under observation for many years, I am able to give more definite information regarding it than is contained in Dr. Lintner's report. In fact, I feel a peculiar personal interest in the insect in question, as it was the first species upon which I made original observations; and in a little work[2] published thirteen years ago I gave a brief account of it.

This grass-pest is exceedingly common and widespread. It is a species of Thrips, which infests the stalk just above the upper

[1] This department is edited by Professor J. H. Comstock, Cornell University, Ithaca, N. Y., to whom communications, books for notice, etc., should be sent.

[2] Notes on Entomology: A Syllabus of a Course of Lectures Delivered at the Cornell University. Ithaca, 1875. (In the second edition of this work the account cited was omitted.)

joint. The young insect pierces the stem in this place, where it is tender, and, sucking the juice from it, causes it to shrink and all parts above the injury to die. It appears first each season upon June grass, and frequently, a short time after this grass has headed out, the fields will be yellow with the dead heads of the grass. Later, the insect spreads to timothy and the other grasses; but it never becomes as common upon these as upon *Poa pratensis*. The species obtains its growth within the sheath of the upper blade, at the point indicated above. After it has acquired wings it crawls forth from this secure retreat, and can be swept from the grass in great numbers. As yet I have been unable to complete the life-history of the species by determining the manner in which it passes the winter and the mode of oviposition. Neither have I been able to suggest any practicable method of preventing the increase of the species. At one time I thought that the early mowing of the infested grass, causing the infested stalks to dry and become unfit food for the young Thrips, would accomplish this purpose, but, later, I found the insects in question feeding upon leaves of grass.

In the work referred to above the species was designated as *Limothrips poaphagus* MSS., but reference was made only to the habits of the insect. A description of the species has not yet been published.—*J. H. Comstock.*

Probable Increase in Entomological Investigations.—Although the United States has taken a very prominent position as regards investigations in economic entomology, the work which the Department of Agriculture at Washington and the few State Entomologists have been able to do has not at all been commensurate with the demands of the subject. The life-history of a very large proportion of the insects that are of economic importance remains unknown. And we are unable, as yet, in many cases where the transformations of the insect are known to suggest any practicable means of preventing its ravages. The field for investigation has been altogether too large to be at all thoroughly worked by the small number of workers employed. There is now, however, a prospect of a change. The establishment by Congress of an agricultural experiment station in each of the States in connection with the agricultural colleges will result in a considerable addition to the number of investigators in economic entomology. No one of the sciences has a more immediate application to agriculture than entomology, and doubtless entomological experiments will form a prominent part of the work of the newly-established stations.—*J. H. Comstock.*

The Report of the State Entomologist of New York.—Dr. Lintner's report for the year 1886 has just appeared. It forms an interesting volume of about seventy-five pages. It is, however,

briefer than would have been the case but for its having been unexpectedly called for at an unusually early date, as explained in the letter of submittal.

The more important entomological events of the year noted by Dr. Lintner are the following: Owing to the ravages of the hop-aphis (*Phorodon humuli*), the hop-crop throughout the State of New York the present year has proven almost an entire failure. It is estimated that only about eight per cent. has been secured—twelve thousand bales in lieu of one hundred and fifty thousand. It is also estimated that one-third of the onion crop was destroyed by the onion-fly, *Phorbia ceparum*.

"A new attack on wheat by a saw-fly larva" is described. The larva in question crawls up the stalk, cuts it off about one inch below the head, and eats the soft green straw. One correspondent states that early in June the ground was thickly scattered with cut-off heads. An injury to strawberry plants, supposed to be caused by *Bembidium quadrimaculatum*, is discussed, but definite conclusions have not been reached. Serious injury to potato-leaves and to the foliage of carrots and parsnips by plant-lice in Massachusetts is noticed.

There are many other short articles on well-known insects. The report is concluded by a list of publications and articles published by the entomologist in various journals during the year, together with an abstract of each. The list includes nearly fifty titles, and is evidence of great industry on the part of Dr. Lintner.

Say's Entomology.—Mr. Howard, in a paper before the Entomological Society of Washington, calls attention to a very general misconception regarding the Leconte Edition of Say's works. This edition does not include all of the entomological writings of that author, and it is evident that the editor simply intended to bring together the descriptive papers of Say.

Giant Lepidopterous Larvæ in Australia.—"The larvæ of *Chalepteryx collesi*, a large moth which has been unusually abundant during the past summer in the vicinity of Sydney, often attains the length of seven inches and is robust in proportion. The larvæ of the beautiful swift, *Zelotypia stacyi*, measures eight inches when fully grown, and I have seen several *Cossus* larvæ of similar dimensions."—*A. Sidney Olliff, Australian Museum, Sydney, N. S. Wales, in "The Entomologist," Vol. XXI., p. 19.*

Insects as Food for Man.—"In Australia the hairless larvæ of such insects as *Zelotypia*, *Hepialus*, *Charagia*, *Pielus*, and many wood-boring Coleoptera—particularly Longicorns and Rynchophora—are eaten raw or cooked by the aborigines and by not a few depraved members of the white community.—*A. Sidney Olliff, l. c.*

THE CHINCH-BUG IN IOWA.—A bulletin of the Iowa Agricultural College, by Professor Osborn, entitled *The Chinch-Bug in Iowa*, has just been issued. It includes a summary of the habits of the species and a discussion of some experiments in controlling this pest.

EMBRYOLOGY.

THE "VENTRAL SUCKERS" OR "SUCKING DISKS" OF THE TADPOLES OF DIFFERENT GENERA OF FROGS AND TOADS.[1]—Thiele in this very interesting paper, shows that the singular sucker-like organs found behind the mouth and under side of the head in the tadpoles or larvæ of frogs and toads differ widely in form in different genera. They are clearly for the purpose of enabling the young larvæ to attach themselves to various fixed bodies in the water, such as weeds, the gelatinous egg-strings and masses from which they have been hatched, etc. They are thus afforded support and prevented from sinking into the ooze to smother, and their enemies thus also doubtless find them a less ready prey. These disks are also shown by Thiele not to be of the nature of suctorial organs, but are glandular, being formed wholly of thickened epidermis which is elevated, its cells becoming lengthened or columnar. There is no muscular suctorial apparatus developed in connection with them, and they are secretory, secreting a sticky mucus or slime which serves to fasten the young tadpole to its resting place. That an actual secretion is formed is proved by the fact that a slimy thread of secreted matter is drawn out from the disk if the young tadpole be forcibly withdrawn from its support. They are specifically larval organs, and persist only for one to two weeks after hatching. They may be compared to the "balancers" found behind the mouth in the larva of *Amblystoma*. In *Triton* stalked suckers are said to be present, which Balfour compares to the sessile "suckers "of larval toads and frogs. But the present writer cannot see how it is possible to homologize the sucking disk of larval gar pikes with the adhesive organs in larval Batrachians, because in the former the disk is in front of the mouth and in the latter it is usually quite behind the mouth, only in one case (Hyla) are the suckers found near the angle of the mouth. The larva of *Xenopus* has two long barbels at the side of the head from the sides of the upper lip. But in this last case even, it is doubtful if there is any homology with the "suckers" of other larval *Anura*. There certainly cannot be any homology between the organ of the gar-pike's larva and that of young toads and frogs, though it is probable that these organs in the latter are truly

[1] Der Haftapparat der Batrachierlarven, von Johannes Thiele. Zeitsch. f. wiss. zool. xliv. pp., 67–79, pl. x. 1887.

homologous with the "balancers" of the larvæ of salamanders of the type of *Amblystoma* and *Triton*.

Thiele further shows that inasmuch as these structures are glandular with no muscular apparatus, that the terms "sucker" or "sucking disk" are misnomers as applied to these organs. A better term might be proposed for these structures in young tadpoles, and the writer would suggest that they be called *epidermal adhesive organs*.

The form of these organs differ widely in different genera of *Salientia* and will afford a valuable means of identifying the larvæ. In *Discoglossus pictus*, the adhesive organ behind the mouth is hemispherical, with a V-shaped groove on its surface, the V opening forward. In *Pelobates fuscus* the adhesive organ is Y-shaped with a Y-shaped groove on its surface and the limbs of the whole organ extending forward to embrace the angles of the mouth. In *Bufo vulgaris* the organ is V-shaped, with a V-shaped groove, and the limbs of the V come into contact with the angles of the mouth. In *Bufo viridis* the organ is cresent-shaped, not in contact with the mouth, but a little behind it, as in *Discoglossus*, and with a widely open V-shaped groove. In *Rana esculenta* and *R. fusca* there are two distinct oval adhesive organs on either side of the median line with traces of a V-shaped groove connecting them, and both are behind the mouth. In *Rana agilis* there are two separate adhesive organs, one on each side behind the mouth, and each has a slight depression on its posterior border. In *Hyla arborea* there are two circular adhesive organs close to the angles of the mouth at either side. In *Bombinator igneus* there are two oval adhesive organs behind the mouth, which are in close contact, and later on fuse into a single organ, both having an oval depression in the centre.—*J. A. R.*

PSYCHOLOGY.

THE COPE-MONTGOMERY DISCUSSION.—*The Theism of Evolution.*—The following is offered as a synopsis of the leading opinions maintained by the writer in a series of articles furnished by him to *The Open Court* during 1887, in reply to articles written by Dr. Edmund Montgomery:—

I. PRINCIPIA.

1. In the universe there exist both mind and matter, subject and object.

2. The evidence for the existence of mind is found in consciousness; first, of ourselves, and, second, of other living beings, whose motions, identical with those which we make under the influence of our own consciousness, convince us of their possession of it.

3. The evidence for the existence of matter is found in certain modifications experienced by our consciousness, especially in the sensations of extension and resistance.

4. Since consciousness does not exist apart from the motion of matter, we regard it as a property of the matter in motion, that is, as a property of energy.

II. FACTA.

1. The gross activity of consciousness is immediately conditioned by matter.

2. In certain of its thought-forms consciousness is not immediately conditioned by matter, but only by its past experience of matter.

3. The forms of consciousness mentioned under (2) control the direction of energy, and hence the use of matter.

4. The proof of (3) is seen in the designed movements of animals in which they direct a current of energy in order to produce a result more or less exactly adapted to satisfy the conditions demanded by a sensation.

5. As soon as a designed movement has been fully acquired, that is, so soon as the animal mechanism necessary for its production has been created, it is performed without consciousness of effort, and may be performed unconsciously, or even in a state of general unconsciousness. Therefore designed automatic acts originated in consciousness.

6. Evolution of organic types is the resultant of the interaction of subject and object, or the living organism and its environment.

7. The function of the organism *in evolution* is to produce variations in its structure as an effect of its motions.

8. The function of the environment in evolution is to impress or destroy the organism, or to restrain, permit or encourage its use; that is, to exercise natural selection.

9. The effect of this interaction, where the movements of the organism are stimulated, is to produce specialized structures and types out of generalized ones. Where the action of the organism is not stimulated, the result is to produce degenerate types.

10. It follows that organic evolution is the result, mediate or immediate, of consciousness; that is, of the interaction of conscious energy or its residua, the organic vital energies, in interaction with the environment.

11. Organic energies perform chemical syntheses and analyses, demonstrating the control of vital over chemical energy.

12. Whereas physical and chemical energies result only in dissipation of energy and integration of matter, the energy of evolution produces complication of matter for the profitable direction and storage of energy.

NOTE.

The only comment which I have to make on Dr. Montgomery's argument is this: that, while denying that conspicuousness can control energy (matter), he admits that matter controls consciousness. These two positions are logically inconsistent. If the affirmative is true of consciousness it is true of matter, and *vice versa*. On other points I can agree fully with Dr. Montgomery.—*E. D. Cope.*

III. CONCLUSIONES.

1. The function of control and construction displayed by the energy of evolution (bathmism) leads us to infer that this type of energy can control its conditions sufficiently to enable it to have a wide distribution in space and time in the universe.

2. Since the originating and controlling element of this *special* type of energy is consciousness, it is inferred that consciousness has existed prior to any given *special* inorganic type of energy.

3. As the condition of consciousness is the unspecialized or uncreated condition of energy, it is inferred that consciousness is a property of matter in an unspecialized or generalized condition in some respect.

4. Since protoplasm is not in all respects the most generalized conceivable condition of matter, it is inferred that there are physical bases of consciousness other than protoplasm.

5. It is inferred from the preceding considerations that the existence of primitive consciousness in primitive forms of matter is not only possible but probable, and this consciousness constitutes a primitive person or Deity.—*E. D. Cope.*

Summary of the Controversy between Professor Cope and Myself.—Professor Cope maintains that mind is the active agent in the organization of living beings. I maintain, on the contrary, that the mind of living beings is itself only a product or outcome of their organization.

Professor Cope's view leads him to assume as original building-material an entirely "unspecialized" kind of matter, and as builder or organizer a supreme mind or Deity inherent in such matter.

In this connection I had to point out the great dilemma of modern philosophy; the impossibility, namely, of conceiving anything mental imparting motion or direction to anything material. Leading thinkers, of almost every school, when seriously contemplating the apparent occurrence of an intercommunication between mind and matter, have declared it scientifically impossible and philosophically inconceivable. Yet, Professor Cope's entire theory of organization through mental agency rests on the flat assertion of its being a self-evident proposition, that our mind moves our body.

I further pointed out that to escape from this distracting dilemma of having on the one side a mind incapable of *naturally* acting upon matter, and on the other side matter incapable of *naturally*

acting upon mind—that to escape this dead-lock in the way of a unitary or monistic conception of nature, a theory of cognition is indispensable.

By help of such a theory we become irrefragably aware that matter and motion are only perceptual signs within our own consciousness of the presence of a non-mental existent and its activity, which are stimulating our senses in specific ways. We can be certain that what thus effects our senses is really *non*-mental in its nature; for nothing mental has power to affect our senses and to awaken specific percepts in us. This non-mental existent and its activity cannot possibly, in the remotest degree, resemble their perceptual representation in us; for how can anything non-mental resemble anything mental? Therefore, they are not in themselves what we perceptually know as matter and motion. And thus the conception of mind moving matter becomes at once irrelevant. The dualistic opposition of matter and mind is seen to be superficial, and only due to inadequte conception on our part.

These truths, yielded by the theory of cognition, I have used to explain our voluntary movements, upon which movements the entire question of the influence of our "mind" on our body actually centers.

Our veritable being has power so to affect the sensibility of an observer as to arouse its perceptual representation in him. This perception of the observer, in all its details, forms clearly part of his own consciousness; but it representatively corresponds to the characteristics of the non-mental existent, which is stimulating his senses.

Now, it is evidently the *transient activity or function* of that part of the *permanent living being* which we perceive as his nerve-system that yields to him all his conscious states.

While this functional play of inner awareness is taking place in the observed organism, the observer himself perceives nothing but motion; motion of molecules in the nerve-system, and dependent movements of peripheral parts of the organism, such as features and limbs.

"Mind" or consciousness is thus a functional outcome of the organization of living beings, and its development is found to keep strict pace with the progressive organization of living forms.—*Edmund Montgomery.—From Open Court, Chicago, March* 1, 1888.

THE RED FOX AT SCHOOL.—Nearing Ashland, Wisconsin, one May day, an Indian lad boarded the train with a basket, in which were three little red foxes (*Vulpes rufus*), their eyes just open, and handsome as little fairies. He expected a bounty for their scalps, but quickly sold one little fellow to me. Too young to know what danger was,—only as an inherited instinct, I determined to see how far he would yield to kind treatment and general domestication.

Returning to my Illinois home, he was fastened by a light chain about fifteen feet long to a pine tree near the back door. Two small dry-goods boxes, placed one above the other, with a door in the same end of each, served as a two-story kennel, the doors facing the house affording ample opportunity for observation. Too young to eat readily, we taught him to drink milk, and gradually to take tender meat, his teeth being at this time only tiny points, weaker—relatively, than a puppy's of similar age. He grew rapidly, and when feeding we held him in our laps, fondling him as a kitten, allowing him to lap and chew our fingers freely. Our shoulder came to be a favorite seat, and until too large, he liked a step still higher; later, to put his fore feet up, then repeatedly to jump from our shoulders to the ground, as we sat upon the grass. He was equally at home in the house where he was given entire liberty. It was now time that he and the cat, with her two kits, should eat and drink together and from the same dish. Kitty, accustomed to having various animals introduced into her home for observation studies, quietly accepted the inevitable. While drinking milk, of which there was always plenty, no jealousy for individual rights appeared, but as the fox grew faster than the kits, and the plate of meat sometimes seemed meager for four, he would eat as fast as possible, snuff a little, as much as to say, "go away,"—give another snuff, and not being heeded, would gently pick up one of the kittens by the nape of its neck, and carrying it off a little ways, set it down, then rush back to the dish, to find the kit there also. This being repeated two or three times, with no satisfactory results, as if out of patience, he would grow more decided and inclined to hurt them a little, making them cry, but they were never conquered. When he had had enough, and a little comparatively was sufficient, if any meat was left, even of the size of a walnut, he would dig a hole, drop it in and with his sharp nose press it down closely, then cover it, and looking about, to be sure of no witnesses, would give a flirt of pine needles over the place, till one could scarcely detect the freshly stirred earth. "Cunning as a fox." If I attempted to find it, he would stand sentinel, and as the spot was neared give a snuff of dislike, but never in his life of nearly two years attempted to bite or bark, nor did we ever see him dig up any of these buried morsels. We tried the effect of raw and cooked meats upon his disposition and found him, after a few days on raw diet, inclined to lap heavier, and chew our fingers harder, but we never feared being bitten.

He greatly enjoyed playing with the kittens but they, being so much smaller and weaker, would tire more quickly and start off to play by themselves. An artifice was at hand to coax them back. Going nearly to the end of his chain, and facing the inside of the circle, though with a keen eye to the outside, he would quietly wag his tail back and forth in the grass. This motion was too great a

temptation for the kits who would chase it, when quick as a flash, he would turn and grasp one, without hurting it but with *such* a look of pleasure and conquest. This feat would be accomplished frequently till all preferred rest or another pastime.

An apple tree stood near the pine, and the young fruit fell freely. With these apples the fox would amuse himself by the hour, playing ball, tossing them and running after them, or tossing them up and catching them in his mouth, also chasing the leaves as they fell to the ground, but he never inclined to gather any materials to make a nest, nor to eat the sour apples.

For persons, he manifested great preferences, and the children who came daily to play with him were no exception. From some, he would take almost anything, especially enjoying a play with their hair as they lay in the grass with him, or to lick their faces and feet, from others he required due reserve, though he never attempted to bite, but often snuffed at them, and held his mouth slightly open, as a cat will, when some disagreeable odor is perceived. When a stranger appeared he was manifestly "foxy," running away as far as he could, and was not readily coaxed by dainty morsels, until some friend came, by whose manner he was assured. My aged grandfather was always kind to him, though in heart he accused him of possible treachery. Did the fox detect this, or why did he in turn always manifest a marked distrust in him? Like a dog, he recognized the foot fall of his friends at a long distance, and would start up and wait for their approach, manifesting great joy on their arrival.

That summer we had a coop of early chicks near the door and for their safety we feared, but soon found that as the fox was sufficiently fed at meal time, these were no temptation to him, and they could pick up crumbs in safety within his own circle.

On several occasions, in his gambols, he broke his chain. Indoors he was readily caught, but when loose out doors, he lost all judgment and did not recognize his surroundings. The yard being large with much shrubbery, to catch him was no trifle, and his instinct to "cover his track" became apparent, often leaping several feet to one side of his course, retracing his steps some distance, then leaping off to one side, or concealing himself behind a bush. When once caught and in our arms, or returned to the house, or his kennel, he could not sufficiently express his joy, lapping our hands and faces, rolling over and over, turning summersaults, etc., etc., in rapid succession. Never was a lost dog happier to find his home than the fox to find his.

At an early age he manifested a slight tendency to burrow, but always in the same place, by the side of his kennel, digging it out and filling it up again, but never, even as winter approached, did he make a space long enough for his body, nor deep enough to conceal himself, rather, only a shallow trench. Was this lack of

provision for the future a direct result of domestication? In summer he often lay in this hollow, but his favorite sleeping place, even in mid-winter was on top of the highest box, the wind playing generally in his long, thick and fine hair. Was this position and his love for sitting on our shoulders or any elevated place a remnant of some arboreal strain? At twilight and by moonlight was his play time, turning summersaults, rolling over and over, jumping from the second story to the first and then to the ground and back, or entirely over his kennel, etc., etc., but though always on the alert, we never noticed anything which indicated discontent or fear, only as strangers came near him.

We tried to teach him various tricks, but for these he developed little aptness, except to return a stick when thrown and to play hide and seek with the children, he appreciating the point quite as much from his standpoint as they from theirs, but a faculty for long continuance at such acquired games was wholly lacking in his nature. When in the house he paid little more attention to the tones of the piano than a dog, though when very rapid and loud numbers were executed he would look earnestly, but not anxiously. With singing and whistling he was always familiar, but the only appreciation he manifested of either was a glad recognition of the voices of his friends; to a scolding tone, or any reprimand directed to him he was very susceptible, closing his eyes as meekly as a dog when reproved. As he seemed to have attained his maximum in mental capacity, and the object of our study had been secured, the second winter he was passed over to the taxidermist; but for a pear, whenever the earth about the pine was stirred, the peculiar odor of the fox was evident, though in playing with him on the grass we rarely detected it.—*Mary E. Holmes, Ph.D.*, Rockford, Ills.

Canine Dissimulation.—Mr. John F. Stafford, of Chicago, owns an English Bull Terrier about two years old. "Shave" is indulged considerably by his master, and occasionally allowed to remain indoors if the weather is bad.

Once Shave had a severe cold and coughed considerably, during which time he was allowed to stay in the house.

Since his recovery when any mention is made of turning him out of doors he coughs vigorously, and wheezes, in fair imitation of asthma.

The trick does not avail him now, however, but he recollects that it did once. When put out he drops the pretence at once and dashes gaily off after neighborhood company.

Shave's mother, it is said, used to ring an electric bell by pressing upon the button in the floor when she wanted to go out. There is a chance for this to be accidental, but the family believe that it is intentionally done. The coughing trick I witnessed once in Shave, and Mr. Stafford says it is often resorted to by the hypocrite.—*S. V. Clevenger.*

ARCHÆOLOGY AND ANTHROPOLOGY.[1]

THE LATE DISCOVERIES OF MR. FRANK CUSHING IN ARIZONA. — Mr. Frank Cushing is well known to the people of the United States for his discoveries and studies among the Zuni Indians. He has added another chaplet to his wreath of fame by the discovery of two other Indian cities, believed by him to have been the habitation of the ancestors of the Zuñis. Mr. Cushing joined the tribe of Zuñis, was adopted by them, and finally was initiated into the order of their priesthood. His escort of a band of Zuñi chiefs and high priests to the States to show to them the Atlantic ocean, the sea of the sunrise, containing the water of life, is well known. His knowledge and information obtained through these long years of intercourse has equipped him for further study and search, and has enabled him to secure success where other men merely book-learned would have failed. He is fairly entitled to the credit of his last achievement.

The Locality. — To visit the scenes of Mr. Cushing's present discoveries, the traveller should take the Southern Pacific Railway, descending at Maricopa, Arizona, about midway between Tucson and Yuma City; from thence a small branch railway, Phœnix and Maricopa Railroad, will take him northeast to Tempe, twenty-five miles. At Tempe by private conveyance to Mr. Cushing's camp, which will be in the neighborhood within ten miles. While at Tempe in the spring of 1887, Mr. Cushing heard of a large truncated mound in the desert six or seven miles to the southeast.

The Discovery.—He visited it, and with that apparent intuition which seems to have been the foundation of his success, he declared it to be of artificial formation, and that it would be found to contain evidences of its construction by man. His workmen were brought from Tempe, who in a marvellous short space of time brought to light the ruins of an immense building. This Mr. Cushing decided to have been used as an Indian temple and for other purposes. He remarked many things which corresponded in a remarkable degree with the Zuñi religion, and which he was able to recognize by reason of his priestcraft. Such a temple, he argued, was part of a great city. He continued his explorations with the result that by the autumn he had discovered a city three miles long and at some places one mile in width. This city was somewhat irregularly laid out, consisting principally of large squares or blocks of houses surrounded by a high wall, apparently for protection. The cause of the ruined condition of the city and its desertion by the inhabitants was determined to have been an earthquake. The adobé walls were shaken at their foundation, and fell outwards. The roof had fallen to the floor crushing everything which had been in the house, in one case the cooking vessel as it sat upon the fire. This evident sud-

[1] This department is edited by Thomas Wilson, Smithsonian Institution, Washington, D. C.

denness of the catastrophe was a factor in forming the belief that there had been an earthquake. The implements of the household and articles in every-day use have been found in many places, and saved. Their examination will afford opportunities for studying the every-day life, and writing the history of these prehistoric people. Many bodies have been found crushed in the débris of the fallen roofs and walls. Many interments have also been discovered. Some were by inhumation, and these were believed to be priests. And herein comes the value of Mr. Cushing's knowledge as a Zuñi priest. These burials were usually made within the houses themselves. The grave was dug in the earth forming the floor, the body placed therein together with the usual articles, receptacles for food, pottery, etc., and being filled up, the floor would soon take its original hardness. The objects thus found interred formed the principal evidence of the priestly character of these dead. The pottery was decorated similar to the modern Zuñi pottery. The same symbols were to be seen thereon. The line of life always open at its extremities was continually present. And referring again to the Zuñi religion, the pottery was left unbroken.

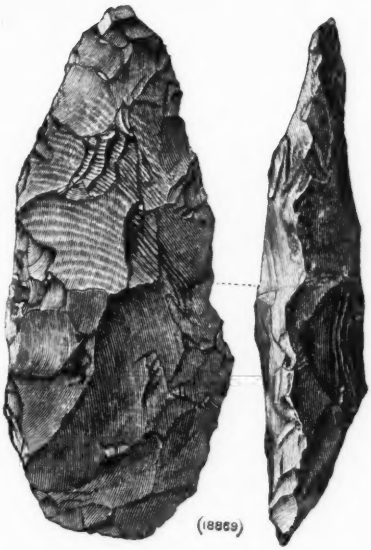
Other cemeteries or graves were found outside the walls. These were of common people, had no traces of priestly character, were frequently by incineration as inhumation, and the vessels accompanying them were always broken. No object in metal was found. This locality, in the midst of an unbroken plain, was without name. Mr. Cushing has named it for identification, *Los Muertos*, The City of the Dead.

Mr. Cushing has discovered another city or town, distant ten or fifteen miles from Los Muertos, being seven or eight miles northeast from Tempe. This has not been excavated to such an extent as has the first, but he finds extensive works for irrigation. Ditches have been cut connecting it with the Salt River, some miles distant, for the conduct of water. For this reason he has named it *Las Acequias*.

Dr. Washington Matthews, Surg. U. S. A., of the Army Medical Museum, visited Mr. Cushing at the scene of his discoveries during the past fall. He found him much broken in health, and sadly in need of rest. Dr. Matthews prescribed for him, relieved him from his duties, and took him to San Diego, to recuperate.

The number of skeletons could scarcely be estimated, but their state of preservation was fairly good, yet requiring care and scientific handling in order to secure them. The finds in this direction have been sufficiently large in number and importance to justify the Museum in sending one of its assistants, Dr. Wortman, charged with the necessary material, who will devote himself to the care and preservation of the skeletons as they are unearthed.

Dr. Ten Kate, a distinguished archæologist of Holland, passed through the City of Washington on his way to join Mr. Cushing.



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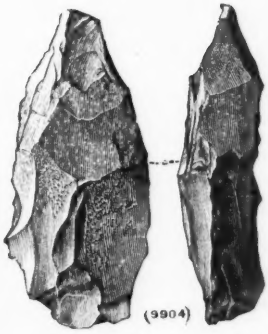
TEXAS.

J. VAN OSTRAND.



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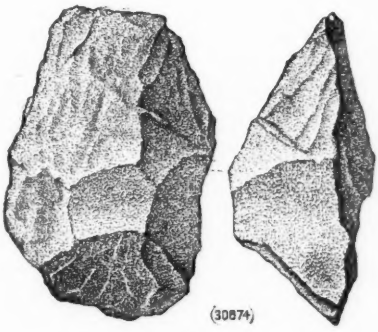
TENNESSEE.

J. PARRISH STELLE.



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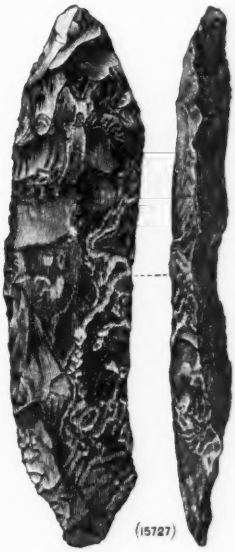
PENNSYLVANIA.

A. F. BERLIN.



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CALIFORNIA.

W. G. HARFORD.

He will remain there, assisting Mr. Cushing in his work during the present winter.

The funds for the expedition are furnished by Mrs. Augustus Hemenway, of Boston.

THE CELTIC SOCIETY OF MONTREAL has recently published an octavo volume of 231 pages, containing some of the papers read before the society during the years 1884 to 1887; to judge from their names, the office-bearers, and perhaps the other members also, are all of Scotch descent. The publisher of the volume, called "Transactions of the Celtic Society," is Mr. William Drysdale, and among the "office-holders" we find also a *bard*, Mr. Archibald Mackillop. The constitution states that the object of the Society shall be the promotion of the study of the "Celtic Language and Literature." The society was organized in December, 1883, and now counts 250 members, many prominent Canadian statesmen among them. Celtic history, folklore and the literature of European States are not the only object of the society, for it also strives to gather and publish all information to be obtained on Celtic settlements in Canada from Nova Scotia to Vancouver Island. Many of these seem to be of an extremely migratory character. The first article is "On the monumental evidence of an Iberian population of the British Islands," and a second one, by the same author, embodies "A translation of the oldest Celtic document extant, and of its Etruscan companion," pp. 159–229, by Professor John Campbell. This Celtic document is nothing else than the seven bronzes, tablets of Gubbio, discovered in 1444, translated and interpreted by Aufrecht and Kuhn, as a sort of ritual of the temple of Jupiter Grabovius at Iguvium (Gubbio) in 1851. But Professor Campbell is by no means satisfied with this interpretation. He finds that the Umbrian language of these tablets is of the *Celtic family*, and that they contain the narrative of a revolt of the colonies of Umbrians and Etruscans in the plains of the Po River, and forthwith proceeds to give a new translation of the tablets, which is probably three times as long as the originals themselves. He states that Upper Italy was then filled with Iberian and Pictish tribes, that Iguvium, the capital, was held by the *eis o Feinne* or Fenians, and that this revolt occurred anno 178 before Christ. The other papers refer to more tangible facts or events of modern times, as "The settling of Glengarry," the "Celt in the Northwest," "Sketch of the Manx language," "Origin of Scottish Highlanders," etc.—*A. S. Gatschet.*

RELIGIOUS BROTHERHOODS OF MOROCCO and the superstitions prevailing among these were made the subject of a communication by Dr. Henry ten Kate to the *Berlin Anthropologic Society* (session of June 18, 1887). We find there: the superstition of the

horse-shoe, that of the protection effected by the outstretched hand, by rags suspended on tree-limbs, the belief in miracle-working springs and fountains, the swallowing of fire, etc.—*A. S. Gatschet.*

GUANAJUATO.—The statistics of this Mexican State, which borders on the west side on Jalisco and Zacatecas, were made the subject of a quarto publication by Antonio Peñafiel, the director of the statistical bureau in Mexico. The title is *Cuadros sinopticos y division territorial de la Republica Mexicana. Estado de Guanajuato.* Mexico, 1887, pp. 192, 4°. This central state has an area of 20,276 square kilometres. The district in which the capital is situated, lies about 2000 metres above the ocean. The State has 1,007,116 inhabitants, the capital, Guanajuato, 52,112. The Indian languages spoken in the State are the Pame, Otomi, Chichimec, Tarasco and Jarapecha, which is a Tarascan dialect.—*A. S. Gatschet.*

Lieut.-Gen. Pitt-Rivers, of the British Army, is known to archæology as well under his former name, Col. Lane-Fox, as under his present name. Upon the decease of an elder brother, he took, as the next heir, the entailed family estates, and by provision of the entail was required to change his name as above. The family estate was at Cranborne Chase, not far from Salisbury. Here Gen. Pitt-Rivers had ample scope to indulge his archæologic tastes in excavations. He has profited by the occasion, and has lately published for private distribution a magnificent quarto-volume, entitled "Excavations in Cranborne Chase, near Rushmore, on the Borders of Dorset and Wiltshire." He has continued his investigations, and read before the Anthropological Institute at London an article in continuation thereof. His article is followed by one of Dr. Beddoe's, which pursues the same line of thought. Both are largely devoted to a calculation of the stature of the prehistoric races, as estimated from the long bones of the skeletons found in the tombs.

The rules adopted by the different authorities eare commented upon in the light of experience by these two gntlemen. They belong to the science of anthropometry, and it would increase the length of this article beyond proper limits to give them. The importance of anthropometry is better recognized in Europe than it has been in the United States, which is much to our detriment. Gen. Rivers says: "I draw the attention of anthropologists to the important point than questions of stature enter so largely into all racial speculations that a uniform system of estimating stature from the long bones is a matter of most ungent necessity." Again, "I have conformed to Dr. Topinard's rules for the sake of uniformity, and in this I am supported by Dr. Garson.

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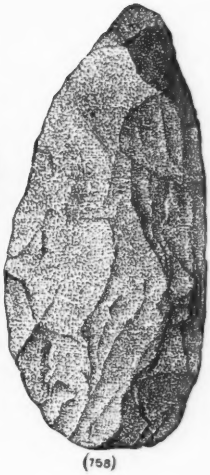
UTAH.
DR. F. V. HAYDEN.



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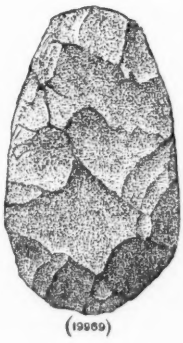
DISTRICT OF COLUMBIA.
JAMES WEBSTER.



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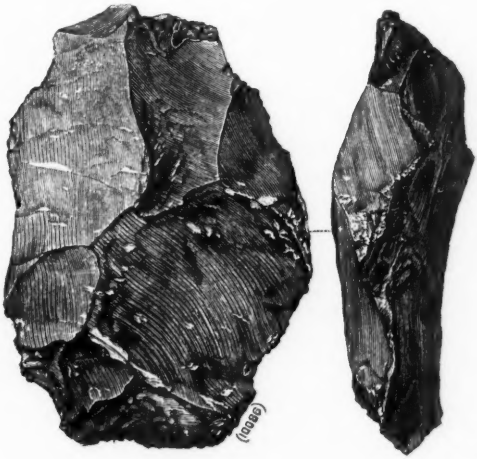
TENNESSEE.
W. M. CLARKE.



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UTAH.
DR. F. V. HAYDEN.

"Dr. Topinard's method, even if it should not turn out to be the best, appears to me sufficiently reliable to serve as a generally accepted standard."

Other articles in the journal of the Anthropological Institute are the Lower Congo; a Sociological Study, by Richard Cobden Phillips; and The Origin and Primitive Seat of the Aryans, by Canon Isaac Taylor.

The Smithsonian Institution has issued the following Circular (No. 36) concerning the Department of Antiquities:—

The Smithsonian Institution desires answers to the following questions concerning that class of American Aboriginal Stone Relics which have been heretofore denominated "rude or unfinished implements of the paleolithic type."

These implements are described by Dr. C. C. Abbott in "Primitive Industry," chap. xxxii., p. 471; by Professor F. W. Putnam "Remarks upon Chipped Stone Implements," from the Bulletin of the Essex Institute, vol. xv., 1883; by Mr. A. F. Berlin in American Antiquarian, vol. i., No. 1, p. 10; by Miss Frances Babbitt in Proceedings of American Association for the Advancement of Science, vol. xxiii., Minneapolis meeting, Aug., 1883, p. 385.

Cuts of some of these implements are herewith given.

QUESTION I.—How many of these rude stone implements have you in your collection?

QUESTION II.—Do you know of any in other museums or collections?

QUESTION III.—Of what material are they made?

QUESTION IV.—Where have they been found?

1. As to locality.
2. Position, condition and associated with what objects?
3. Whether on or under the surface, and, if so, at what depth, and in what kind of geological formation?
4. Were they found in mounds, tombs or other ancient structures?
5. Were any other ancient implements found with them, and, if so, of what kind?
6. Did their deposit seem to be accidental or intentional?
7. Have they been described in any publication, and, if so, in what, and where can it be obtained?
8. Can you forward specimens (as many as possible) to this Museum in exchange for publications or duplicate specimens?

—*S. P. Langley, Secretary Smithsonian Institution.*

MICROSCOPY.[1]

PLASTER TABLETS FOR MOUNTING ANATOMICAL PREPARATIONS.—Mr. H. Garman, of Champaign, Ill., finds tablets made of plaster preferable to most others for mounting anatomical preparations. The following communication on this subject has been received from Mr. Garman:—

"My experiments with this material were made without knowledge of its use for the purpose in other quarters, and I was surprised to learn, upon inquiry, that the large white tablets used for ordinary alcoholic specimens in the Museum of Comparative Zoology were of plaster, and had been cast upon glass. However, I believe the manner of making them, and the facility with which they can be produced, is not as generally known as it should be, and that, as my results were reached independently, the details of the method here given may prove of service even to those who are accustomed to the use of plaster. I do not know that colored plaster tablets have been used by others.

"The tablets are made by mixing good plaster of Paris with water until the mixture is of the consistency of thick cream. It is then poured upon plates of glass, and after it has "set" the tablets are roughly marked out with a knife blade. In about twelve hours they can be taken from the glass and trimmed more exactly with the aid of a ruler. They can be made of any desired thickness, and when fully hardened are sufficiently strong to endure the handling to which they are liable. The soft plaster may be spread uniformly and its upper surface be made smooth by taking the glass bearing it between the hands, and moving it abruptly from side to side a few times. If, after the tablets have become dry and hard, it is desired to trim them, or to alter their shape, it can readily be done with a knife after first soaking them in water.

"Dissections or other objects are fastened in position with thread passed, by means of a needle, through the edges of the object, or around some part of it, and tied at the back of the tablet. Or holes may be drilled through the tablet and the thread be secured after passing through them.

"Common prepared bluing is a good coloring material, and mixed with plaster in proper quantities can be made to give a range of hues from blue-gray to deep blue that, with the pure white of uncolored plaster, satisfies most needs in the way of backgrounds. Black ink and carmine staining fluids can be used to stain the white tablets. But the latter color is not often a desirable one, and if it is to be used can be more economically applied by first dissolving carmine in water with heat, then adding the plaster, finally casting

[1] Edited by C. O. Whitman, Director of the *Lake Laboratory*, Milwaukee.

upon glass. Lampblack will not, in its ordinary form, mix with plaster. A variety of colors may be obtained by using the 'Florentine Fresco Colors' sold by F. W. Devoe & Co., New York. They may be mixed with the plaster. The chrome orange, chrome yellow, Venetian red and ivory black have been on trial in tablets for about a week, and show no change under the alcohol.

"The use of plaster in tablets is not claimed to be new with the writer, but this method of manipulation and coloring is the result of independent experiment, and may therefore present some features of interest. Tablets as above prepared have proved, in my experience, superior to those made of wax in the matter of cost, in the facility with which they are to be prepared, and in neatness of appearance."

Preparation of the Eggs of Ascaris megalocephala.—Through the researches of M. Nussbaum,[1] Ed. van Beneden,[2] J. B. Carnoy,[3] and Otto Zacharias,[4] the egg of *Ascaris megalocephala* of the horse has become a classical object for the study of fecundation. In the simple structure and enormous size of its nuclei, this egg offers unequalled advantages for such study. But a very serious drawback is found in the thick impervious egg-membrane, which is capable of resisting for a long time the action of preservative reagents. Dilute acetic or nitric acid requires at least from eight to ten days to penetrate; and alcohol of 40 to 50 per cent., two or three months. Development goes on undisturbed in osmic acid of 1 per cent.; and several days are necessary even for absolute alcohol to take effect.

For tracing the karyokinetic phenomena of fecundation, it is of the utmost importance to find reagents that will kill and fix quickly, as reliable preparations of transitory stages in nuclear metamorphosis cannot be expected with reagents that penetrate slowly.

Otto Zacharias[5] has discovered an acid mixture which overcomes the resitence of the egg-membrane, and fixes the egg completely within 25 to 30 minutes. The mixture consists of

Alcohol (90 to 100 per cent.)	80 ccm.
Glacial acetic acid	20 ccm.
Osmic acid (1 per cent.)	20 to 30 drops.

A little glycerine or chloroform increases the clarifying power of the mixture.

[1] Archiv f. mik. Anat., xxiii., 1884.
[2] Archives de Biol., iv., 1884.
[3] La Cellule, 1886-7.
[4] Archiv f. mik. Anat., xxx., H. 1, 1887.
[5] Ueber Abtödting und Färbung der Eier von Ascaris megalocephala. Anatomischer Anzeiger, iii., 1, p. 24, Jan., 1888.

Van Beneden (*Nouvelles Recherches sur la fécondation, etc.*, 1887) has employed a stronger mixture, consisting of absolute alcohol and acetic acid in equal parts, without the addition of osmic acid.

Preparation of Material.—1. Freshly obtained[1] Ascaris females are placed between two sheets of cotton, which have been moistened a little in a 3 per cent. solution of common salt, then covered with a bell glass, and exposed one to three hours to an incubation temperature of 25°C. This procedure brings the polar globules to development in the younger eggs, and forces the cleavage in the older eggs.

2. After an hour's incubation, it is well to preserve a part of the material at disposal. The genital sacks are laid bare by a longitudinal slit in the body-wall, opposite the sexual aperture; the vagina is then cut free from the body, the alimentary tract lying between the two sacks is carefully removed, and the ovarian portions of the sacks are cut off, leaving the uterine portions with their contents for preservation. The anterior ends of the uteri contain eggs in all stages of maturation and fecundation; the posterior ends contain eggs already beginning to cleave. The killing and hardening process should vary considerably for these different stages.

3. It is advisable, therefore, to cut each uterus into thirds, and to expose the anterior third to the action of the acid mixture only five to seven minutes, the middle third ten to fifteen minutes, and the posterior third at least twenty-five minutes. After fixation, the anterior and middle thirds are transferred to 30 per cent. alcohol, and after a few hours to 50 per cent. alcohol, in which they may be kept for a long time. Eggs in process of cleavage—found in the posterior third—should be removed to absolute alcohol the moment they begin to show a light brown staining. After two to three hours they are to be transferred to 70 per cent. alcohol for preservation. If the acid mixture be heated to about 24°C., the posterior third of the uterus will require an exposure of only ten to fifteen minutes.

4. *Schneider's acid carmine* is an excellent staining agent. It is prepared as follows: Glacial acetic acid is diluted with distilled water to about 50 per cent.; then as much pulverized carmine is added to the boiling acid as will dissolve. After filtering until the fluid becomes clear, a little rectified wood-vinegar is added (one drop *A. pyrolignosum* to ten ccm. of the carmine solution) for the purpose of strengthening the clarifying power of the mixture.

The younger stages may be left in the dye three to four hours, the older stages eight to ten hours.

Beautiful views of the karyokinetic figures are thus obtained, but they are not permanent. After three to four hours they begin to lose in distinctness.

[1] From the living horse, by means of arsenic pills.

Grenacher's alcohol carmine gives more durable preparations. Eggs thus stained may be improved by treatment with *methyl green* (2 per cent.), to which has been added a few drops of glycerine. The spindle-fibres of the first and second amphiasters may be most successfully stained with "Modebraun," in very dilute aqueous solution. Preparations are mounted in dilute glycerine (glycerine two parts, distilled water one part).

SCIENTIFIC NEWS.

—The *Journal* of the Royal Microscopical Society has just completed its first decade, and the last number of its tenth volume contains an editorial "preface" by the editor, Mr. Frank Crisp, paying a deserved tribute to his associate editors and especially to Professors F. Jeffrey Bell and A. W. Bennett, who for these ten years have prepared those abstracts of the biological literature of the world which have made the Journal indispensable to every naturalist who wishes to keep up with other subjects outside his specialty.

—George W. Tryon, Jr., the Conchologist, died in Philadelphia February 6th, aged fifty years. Although not a Friend, his education was gained at Friends' school, and at an early age he engaged in business with his father and brother. The lack of collegiate education he amply made up in later life by private study. His early years were devoted assiduously to his business and to his studies, and his attention having been concentrated on natural history, and especially on the study of shells, he withdrew in 1867 from business in order to devote himself solely to his favorite pursuit. A man of untiring energy and perseverance, he soon became eminent in this domain of science. His first paper was published in the proceedings of the Academy of Natural Sciences for 1861, under the title "On the Mollusca of Harper's Ferry, Virginia." In 1865 he established the "American Journal of Conchology," of which seven annual volumes were issued. To this, and to the proceedings of the Academy he contributed numerous papers, numbering at the end of 1873 no less than sixty-four contributions to this favorite science, all showing characteristic accuracy of detail and patient research. In addition to these papers he also issued a Bibliography of American Writers on Conchology in 1861; a Monograph of the Fresh Water Univalve Mollusca of the United States, in continuation of Haldeman's work on the same subject; a Synonymy of the Species of Strepomatidæ in 1865; a Monograph of the Terrestrial Mollusca inhabiting the United States, 1866; an American Marine Conchology, 1873; the third volume of the Land and Fresh Water Shells of the United States, published by the Smithsonian Institution, and a Structural and

Systematic Conchology, in two volumes, issued in 1883. The latter is a magnificent work, profusely illustrated, but was only preliminary to the crowning work of his life, which, unhappily, he has been unable to finish. This was his Manual of Conchology, Structural and Systematic, of which the first volume appeared in 1879, and of which nine volumes of the first series, on marine shells, and three of the second, on land shells, have been issued. It is no exaggeration to say that this is the most extensive systematic work on any branch of natural science which has yet appeared in the United States. The collection of shells of the Philadelphia Academy of Natural Sciences was largely his gift to the institution, and it was one of the largest in the world. The library of this institution is also one of the most complete in the world on this subject, chiefly through Mr. Tryon's exertions. Mr. Tryon was also well known in musical circles. He edited for Lee & Sheppard a pamphlet series of operas, which is very popular, and essayed on several occasions original music work, including an opera.

—Asa Gray.—Born in Sauquoit, Oneida county, N. Y., November 18, 1810. Died in Cambridge, Mass., January 30, 1888.

When a great man dies, it is fitting that his survivors should recount his deeds, and learn the lessons which his life and labors teach. Born in the poverty and obscurity of a backwoods village, far from any of the great centres of learning, there was nothing of promise in the future for the little tanner boy of the Mohawk Valley. When he urged the unwilling horse on his tiresome round, and wearily labored at his monotonous task of feeding the bark-mill, who could have foretold his after greatness? What prophet could have seen in the village school-boy, so far removed from all incentives to the study of science, the future leader of one of the great branches of science in America?

Denied the advantages of a collegiate education, he completed, at the age of twenty, the study of medicine in the Fairfield College of Physicians and Surgeons for the Western District of New York, and doubtless the scientific studies of the course had much to do with making him what in his after life he always was, emphatically a scientific man. His botanical work began during his study of medicine, and by the time of his graduation he had already done something in the way of collecting and identifying the plants of his locality.

The great event of the young botanist's life was his meeting, when twenty-one years of age, with Dr. John Torrey, then teaching in New York City. Under the inspiration of Torrey, his studies were led into those lines of work in which his life was destined to be spent. In his herbarium and by his help Gray's first botanical contribution (viz.: "North American Gramineæ and

Cyperaceæ") was wrought out. In the introductory note to part I, which bears date of February 1, 1834, acknowledgment is made of the author's obligations to Torrey "for the interest he has taken in his botanical pursuits, for the important aid he has rendered him in the determination of doubtful species, and for the use of his valuable library and herbarium."

In his twenty-ninth year Dr. Gray visited Europe, and made the acquaintance of many of the great botanists of that time,—the elder and the younger Hooker, Bentham, Greville, Robert Brown, Lindley, Mirbel, Decaisne, St. Hilaire, Boissier, Adrien de Jussieu, Endlicher, Von Martius, the De Candolles, Schlechtendal, Kunth, Ehrenberg and many others.

Three years later he was called to the chair in Harvard College, which he filled for thirty-one years, until relieved of the drudgery of teaching in 1873. When sixty years old he was elected president of the American Association for the Advancement of Science, at the meeting held in Troy, and two years later delivered his famous address, "Sequoia and its History," at Dubuque.

Upon the anniversary of his seventy-fifth birthday the botanists of the country united in a testimonial of respect and veneration to the one on all hands acknowledged to be their leader. Last year, on his revisiting England and Scotland, the Universities of Oxford, Cambridge and Edinburgh, honored themselves as well as him by conferring upon him their highest degrees.

The activity of his mind throughout a long life may be indicated by the following list of the more important of his publications, with the age at which they were issued:

At 24.—North American Gramineæ and Cyperaceæ.

At 26.—Elements of Botany.

At 28.—A Flora of North America (in conjunction with Dr. Torrey).

At 32.—The Botanical Text-Book.

At 35.—The Botanical Text-Book. Second Edition.

At 36.—Chloris Boreali-Americana. Decade I.

At 38.—A Manual of the Botany of the Northern United States.

At 38.—The Genera of the Plants of the United States, illustrated by figures and analyses from nature.

At 40.—Plantæ Wrightianæ Texano-Neo-Mexicanæ. Part I.

At 40.—The Botanical Text-Book. Third Edition.

At 42.—Plantæ Wrightianæ Texano-Neo-Mexicanæ. Part II.

At 44.—Botany of the United States Exploring Expedition.

At 46.—Manual of the Botany of the Northern United States. Second Edition. [Extended so as to include Virginia, Kentucky and all east of the Mississippi.]

At 47.—First Lessons in Botany and Vegetable Physiology.

At 47.—The Botanical Text-Book. Fifth Edition.

At 48.—How Plants Grow.

At 49.—The Relations of the Japanese Flora to that of North America.

At 57.—Manual of the Botany of the Northern United States. Fifth Edition.

At 58.—Field, Forest and Garden Botany.

At 62.—Sequoia and its History (President's Address, A. A. A. S.).

At 62.—How Plants Behave.

At 66.—The Gamopetalæ of the "Botany of California."

At 66.—Darwiniana.

At 68.—Synoptical Flora of North America. Gamopetalæ after Compositæ.

At 69.—Botanical Text-Book. Sixth Edition.

At 70.—The Vegetation of the Rocky Mountain Region (in conjunction with Joseph D. Hooker).

At 74.—Synoptical Flora of North America. Caprifoliaceæ to Compositæ.

At 77.—The Elements of Botany for beginners and for Schools. —*Charles E. Bessey.*

—A statement by me in the December *Naturalist*, relative to Mr. Harger's participation in the authorship of the volume on the Dinocerata, it has been claimed was unjust. Injustice to no one was intended, nor was there any personal feeling in the matter. My sole desire was to make it known, as no one else could, that a very large portion of Mr. Harger's scientific labors for the past seventeen years has been quite unknown to the scientific world. This is conceded by those most interested in the matter, and any details as to the precise part of the work that he committed to paper is immaterial. Professor Marsh insists that a portion of the descriptive matter of the Dinocerata was written by himself, and presents evidence which I will admit sustains his assertion. The chapters on the brain and skull I have in my notice of Mr. Harger conceded to him without in any way affecting the general fact. He must and will admit that a considerable part of the work was prepared by Mr. Harger without his name appearing anywhere as its author. I have nothing to say as to whether such a course was right or wrong. Others, with Professor Marsh, may claim that an author has a right to hire and pay for scientific work, without its being any one else's affair. I do say, however, without fear of denial, that much of the valuable scientific work published by Professor Marsh has been due to the conscientious accuracy, sound judgment, and general scientific scholarship of Mr. Harger. *The bibliography* was almost wholly prepared by myself, but was so modified that I should be loth to have its authorship imputed to me.—*S. W. Williston, Yale College, New Haven.*

—The Committee on the Marine Biological Laboratory have issued an appeal for aid in establishing the laboratory, from which we learn that $8,000 of the desired $15,000 have already been secured, and that it is proposed to start work before the full endowment has been secured. It is hoped—first, to secure a location at Woods Holl, Mass., where the fauna and flora are abundant and varied; second, to build a laboratory with two stories—the lower story to have accommodations for teaching at least twenty-five persons, the upper story to have work-places for investigators—to furnish aquaria, microscopes, microtomes, glassware, etc., also a constant supply of water for aquaria; third, to have a convenient landing, boats, collecting apparatus, etc. To meet the running expenses, fees will be charged those who work at the laboratory. The laboratory is to have two principal objects—first, the education of competent teachers of biology; second, the furnishing of suitable facilities for original investigation, such as are afforded students in Europe.

—The Boston Society of Natural History is agitating the establishment of an aquarium and zoological garden.

—Mr. Andrew Garrett, who has done so much to explore the molluscan fauna of the South Sea Islands, died in the Society Islands Nov. 1, 1887.

—George Robert Waterhouse, of the British Museum, died in Putney January 21, 1888. His later years were devoted to geology, but some years ago he published a commencement of a monograph of the Mammalia, a very useful work, which deserved completion.

—Dr. Max Schmidt died in Berlin February 3, 1888, in his fifty-fourth year. He was formerly Director of the Zoological Garden in Frankfurt-on-the-Maine, but in 1884 was called to a similar position in Berlin, as successor to Dr. Bodinus.

—Dr. D. S. Jordan sails in June for Europe. It is his intention to proceed to Greece to study the fish-fauna of the Eastern Mediterranean.

—Professors O. P. Jenkins and B. W. Evermann have just received the collections which they made during last summer at Guaymas, on the Gulf of California. They are especially rich in fishes, some twelve species being new.

—August Friedrich, Count Marschall, the author of the Nomenclator Zoologicus (published in 1873), died in Vienna October 11, 1887.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BIOLOGICAL SOCIETY OF WASHINGTON.—February 11, 1888.—The following communications were read:—Dr. Theo. Gill, "Character of the Family *Elacatidæ*;" Mr. Robt. T. Hill, "The Variations of *Exogyra ponderosa* Say;" "The Variations of *Gryphæa pitcheri* Morton;" Prof. C. V. Riley, "The Insectivorous Habits of the English Sparrow;" Dr. C. Hart Merriam, "A New Fox from California."

February 25, 1888.—The following communications were read: Mr. F. W. True, "Changes in the Catalogues of North American Mammals since 1879;" Dr. T. H. Bean, "Distribution and Some Characters of our Salmonidæ;" Dr. Cooper Curtice, "Some Early Stages in the Life History of *Tænia pectinata*."

March 10, 1888.—The following communications were read:—Mr. F. W. True, "Changes in the Catalogue of North American Mammals since 1877," Part II.; Dr. Geo. Vasey, "Foreign Trees and Shrubs Cultivated in the District of Columbia;" Dr. Theo. Gill, "The Classification of Cottoidean Fishes;" Dr. C. Hart Merriam, "Description of a New Species of American Skunk;" Mr. Robt. T. Hill, "The Southwestern Termination of the Atlantic Timber Belt."

March 24th.—Dr. Cooper Curtice spoke of "*Tænia fimbriata*, a New Parasite of Sheep;" Mr. Charles Hallock, "Reversion of Domesticated Animals to a Wild State;" Capt. J. W. Collins, "The Work of the Schooner Grampus in Fish Culture."

APPALACHIAN MOUNTAIN CLUB.—Boston, January 3, 1888.—Prof. David P. Todd, of Amherst College, gave a paper describing his ascent of Friji-San, Japan, in connection with the recent eclipse expedition. The lecture was illustrated with stereopticon views.

January 10, 1887.—Annual meeting. The report of the secretary showed a total membership of 788, a gain of 15 during the year. In 1887 there were held nine regular, six special, and one field meeting. There were besides ten excursions. The following board of officers were elected: President, Augustus E. Scott; vice-president, Rest F. Curtis; recording secretary, Roswell B. Lawrence; corresponding secretary, Frank W. Freeborn; treasurer, John E. Alden; councillors—Natural history, George Dimmock; topography, George H. Barton; art, John Ritchie, Jr.; exploration, Frank O. Carpenter; improvements, Frederick D. Allen; trustee, for three years, Charles W. Kennard. After the result had been announced, Miss L. S. Davis gave an account of the dedication of the monument to De Saussure, and Mr. L. L. Hubbard made a few remarks concerning the convention at Villach, which he attended as delegate of the club. On Saturday, January 14, the club visited Pasture Hill, and on the 21st an excursion was made to Mt. Benedict.

SOCIETY OF ARTS.—Boston, January 10, 1888.—Prof. W. T. Sedgwick read a paper entitled "A Biological Examination of the Water Supply of Newton, Massachusetts," it being a record of joint work done on the subject by the speaker and Mr. S. R. Bartlett. A description was first given of the filter basin near the Charles River, from which the Newton supply is taken. A striking difference was found to exist between the river and basin water. Water from the river gave as an average 261 colonies of Bacteria in a cubic centimetre; that from the basin, 42; from the reservoir, when the water is pumped, 23; and that taken from the tap in Newton, only 6. The following results bear out the opinion that Newton's water supply is superior. Newton water was thus found to contain 6 micro-organisms in a cubic centimetre; Spot pond, Malden, 10; Cochituate, 43; Mystic, 204; Croton, N. Y., from 54 to 256. The chemical tests also justified the reputation of the Newton water for purity.

The next paper, also read by Prof. Sedgwick, explained a "New Method for the Biological Examination of Air," by Prof. Sedgwick and Mr. G. R. Tucker. A description of the previous methods used for this purpose was first given. In the new method the air is drawn through a small tube containing granulated sugar, the sugar being then mixed in an enlargement of the same tube, with a proper amount of gelatine to insure the growth of any germs held by it. The apparatus for drawing always the same amount of air through the tube is an ingenious one, and is the invention of Mr. Tucker. It has been found by numerous experiments that the sugar catches all the Bacteria of the air. The apparatus is simple in construction and working, and is designed to be used in hospital wards and at any place where frequent examinations of the air are desired. It was shown in working order, and a large number of plates and tubes showing micro-organisms in various stages of development were exhibited.

AMERICAN PHILOSOPHICAL SOCIETY.—May 20, 1887.—A paper from Prof. S. S. Stevenson, entitled "Notes on the Surface Geology of Southwest Virginia," was presented.

September 2, 1887.—The following communications were read: On "Biela's Comet and the Large Meteors of November 27–30," by Prof. Dan. Kirkwood, Bloomington, Ind.; On the "Systematic Position of the Mallophaga," by Prof. A. S. Packard, Providence, R. I. "Preliminary Report of the Vertebrate Fossils of the Uinta Formation, collected by the Princeton expedition of 1886," by Profs. W. B. Scott and Henry T. Osborn, Princeton, N. J.; Dr. D. G. Brinton read a paper entitled "Were the Toltecs an Historic Nationalty."

September 16, 1887.—A paper by Dr. A. C. Stokes, of Trenton, N. J., on some "New Fresh-Water Infusoria was presented."

October 7, 1887.—Prof. Cope presented a communication for the proceedings entitled the "Classification and Phylogeny of the Artiodactyla." Two communications from Mr. S. Garman, of Cambridge, Mass., entitled "Reptiles and Batrachians of Grand Cayman," and "West Indian Reptiles in the Museum of Comparative Zoology, Cambridge, Mass.," were read.

October 21, 1887.—Mr. P. C. Garrett read an obituary notice of Pliny-Earle Chase, LL. D., a vice-president of the Society. A paper on "Octonary Numeration and its Application to a System of Weights and Measures," by A. B. Taylor, was presented. Prof. Cope read a paper on the "Phylogeny and Classification of the Artiodactyla. Dr. J. Cheston Morris spoke of the remarkable resemblance between Devonshire sheep and goats, both ewes and bucks had horns and, like the goat, they had more than one period of reproduction in a year. Dr. D. G. Brinton, H. Phillips, Jr., and M. B. Snyder, were appointed a committee to consider the value of *Volapük*.

November 4, 1887.—Dr. Brinton read a paper on the so-called *Alaguilac* language of Guatemala.

November 18, 1887.—A paper entitled "Notes on the Ethnology of British Columbia," by Dr. F. Boas, was presented through the Secretaries. Dr. Brinton read an account of "An Ancient Human Footprint from Nicaragua," and in the discussion that ensued Prof. Heilprin stated that in his belief the deposit in which it occurred was Post-pliocene. Prof. E. J. Houston read a communication on a non-magnetizable watch invented by M. C. A. Palliard, of Geneva, Switzerland; and on the Gramophone, an invention of Edwin Berliner, of Washington, D. C. Prof. E. F. Smith presented a paper on "Electrolysis of Lead Solutions."

December 2, 1887.—Prof. D. Kirkwood, of Bloomington, Ind., presented a communication on "The Possible Existence of Fireballs and Meteorites in the Stream of Bielids."

January 6, 1888.—The committee of *Volapük* presented a supplementary report. Prof. P. H. Uhler, of Baltimore, read a paper on "The Albirupian Formation and its Nearest Relatives in Maryland." Profs. Lewis and Heilprin, in the discussion which followed, differed from Prof. Uhler in their views of the age of this formation, Prof. Lewis considering it as Silurian, Prof. Heilprin as Palæozoic and not Mesozoic.

Western Society of Naturalists.—A Western Society of Naturalists, embracing members from Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa and Missouri, was organized at Indianapolis, Dec. 29th, 1887. Its scope is like that of the American Society of Naturalists, the constitutions of the two being almost identical. The following officers were elected:—President, Profes-

sor S. A. Forbes, of Champaign, Ill.; Vice-Presidents, Professor W. J. Beal, of Agricultural College, Mich., Pres. T. C. Chamberlain, of Madison, Wis., and Professor Henry L. Osborn, of Hamline, Minn.; Secretary, Dr. J. S. Kingsley, of Bloomington, Ind.; Treasurer, Dr. John M. Coulter, of Crawfordsville, Ind. It was voted to hold the annual meetings of the Society in October, the first one to be held at Champaign, Ill. The first meeting was for organization and had no regular programme. Various members discussed methods of biological investigation and instruction. Dr. S. A. Forbes exhibited a number of pieces of microscopical apparatus in use in the Illinois State University and especially adapted for drawing microscopic objects.

Boston Society of Natural History, December 21, 1887.—The meeting was devoted exclusively to the Antiquity of Man in America. Professor F. W. Putnam exhibited a series of palæolithic implements found in the gravels at Trenton, New Jersey, by Dr. Abbott; in the gravel of the Little Miami Valley, Ohio, by Dr. Metz, and in the glacial deposit at Little Falls, Minnesota, by Miss Babbitt; also, for comparison, several from the gravel of the Valley of the Somme. Dr. Charles C. Abbott gave an account of the recent discoveries in the Trenton gravels and their bearing on the antiquity of man in North America. Professor G. F. Wright spoke upon the age of the Ohio gravel-beds in which the implements were found by Dr. Metz. Mr. Warren Upham read a paper upon the recession of the ice sheet in Minnesota in its relation to the gravel deposits overlying the quartz implements found by Miss Babbitt at Little Falls, Minnesota.

A discussion upon the Antiquity of man in the eastern and central portions of America followed the reading of the papers.

January 4, 1888.—Professor W. O. Crosby discussed the Geology of the outer islands of Boston Harbor. Mr. James H. Emerton described the Anatomy of the Chrysalis of the Milk Weed Butterfly.

February 1, 1888.—Mr. E. O. Jordan, of the Institute of Technology, read a paper on the beginnings of natural history in America.

February 15, 1888.—Dr. Geo. L. Goodale read a sketch of the life and work of the late Dr. Asa Gray.

March 7, 1888.—Professor W. O. Crosby read a paper on the geology of the Black Hills of Dakota.

March 21, 1887.—Professor F. W. Putnam described the great serpent-mound in Ohio, and Dr. J. W. Fewkes discussed the origin of the present form of the Bermudas, both papers being illustrated by the stereopticon.

Essex Institute, March 19, 1888.—Professor F. W. Putnam

spoke of the serpent-mound in Adams county, Ohio, which has recently come into possession of the Peabody Museum of American Archæology and Ethnology, at Cambridge, Mass. This mound was first brought to general knowledge by Messrs. Squire and Davis in 1849, previous to which time it had only a local reputation. It was then covered with forests, and has since been ploughed over a number of times and devoted to crops. The mound is lowest at the tail and increases in height toward the head, and varies from four to nine feet; in width it varies from eleven to twenty-one feet, and its length is about fifteen hundred feet. The serpent makes four or five convolutions, running north and south, and the tail ends in a triple coil. In front of the mouth is an oval mound, as though the serpent were about to swallow an egg—as the lecturer expressed it. On each side of the neck are two other mounds—one natural, growing out of the decay of an enormous oak tree, and the other artificial. Near the tail is another mound, built up from the white clay bottom, over which is a heavy layer of stones—not the limestone of the surface, but a sandstone brought from a creek a quarter of a mile away. In this mound, at a depth of from two to five feet, occur a considerable number of intrusive burials; but in the centre, lying at length on four inches of wood-ashes, was found the skeleton of a chief six feet in height, with a brain capacity greater than that of Daniel Webster. The speaker believed the mound to have been built in honor of this chief. The skeleton is in good condition, and is now preserved in the Museum at Cambridge. No weapon was found in the mound and no ornament, except one fresh-water clam-shell.